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DRAFT FINAL
TECHNICAL MEMORANDUM

EVALUATION OF AMMONIA AND SUPPLEMENTAL SOIL DATA

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 116-RICO-0107
TtNUS Project No. GN4123

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ACRONYMS AND ABBREVIATIONS

CCC	Criterion Continuous Concentration (chronic)
CMC	Criterion Maximum Concentration (acute)
COPC	contaminant of potential concern
Cr	chromium
CT	central tendency
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
FS	Feasibility Study
GSIP	Groundwater/Surface Water Investigation Plan
HBHA	Halls Brook Holding Area
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effect level
MADEP	Massachusetts Department of Environmental Protection
MBTA	Massachusetts Bay Transportation Authority
MCL	maximum contaminant limit
M&E	Metcalf & Eddy, Inc
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MSGRP	Multiple Source Groundwater Response Plan
MSGRP RI	Multiple Source Groundwater Response Plan Remedial Investigation
NA	Not analyzed / Not applicable
NAS	Natural Attenuation Study
ND	Not detected
NERL	(EPA) New England Regional Laboratory
NML	northern multi-level (sampler)
NPDWSA	Non-Potential Drinking Water Source Area
NRWQC	National Recommended Water Quality Criteria
ORD	(EPA) Office of Research and Development

ACRONYMS AND ABBREVIATIONS (cont.)

OU	Operable Unit
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Parties
RAGs	Remedial Action Guidelines
RAO	remedial action objective
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
STSC	Superfund Technical Support Center
TAL	target analyte list
TRV	toxicity reference value
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency

ES EXECUTIVE SUMMARY

Following a review of groundwater and surface water data that was presented in the March 2005 Draft Final Multiple Source Groundwater Response Plan Remedial Investigation Report (MSGRP RI), the U.S. Environmental Protection Agency (EPA), has identified ammonia as an additional contaminant of concern for the Industri-plex Superfund Site Operable Unit 2 (Industri-plex OU-2). This technical memorandum presents the findings of this evaluation.

Section 2.0 of the MSGRP RI presents a detailed discussion of each groundwater sampling event conducted during the Industri-plex OU-2 MSGRP RI. The analytical results of these sampling events are included in Appendix 4B of the MSGRP RI, and a summary of analytical results is set forth in Table 2-1. The data presented in Appendix 4B includes anion and cation data, which includes ammonia from 39 monitoring wells. On June 24, 2005, EPA's Office of Research and Development (ORD) released an internal memorandum entitled "Ammonia Data For Water Quality Samples" (June 24 ORD Memo), which presents ammonia groundwater and surface water data that were collected as part of the Natural Attenuation Study (NAS), conducted to support the MSGRP RI. The memorandum and data were included in the June 2005 Administrative Record. In addition to the NAS groundwater and surface water ammonia data, EPA collected and evaluated the following additional surface water and soil data: 1) July 2005, ammonia surface water data (to further understand background conditions); and 2) July 2005, heavy metals soil data (to further evaluate an area being considered by the City of Woburn for future recreational trails).

EPA has determined that previously identified contaminated groundwater plumes outlined in the June 2005 Proposed Plan and illustrated on Figure 3-1 also contain high concentrations of ammonia. The decomposition of the buried animal hide wastes at the Operable Unit 1 of the Industri-plex Site (Industri-plex OU-1) contribute significantly to the generation and release of ammonia in groundwater. In addition, the contaminated groundwater plumes contain strong reducing conditions which contribute to the presence and migration of high ammonia concentrations in the groundwater and its discharge into the HBHA Pond. The fate and transport of ammonia is similar to the fate and transport patterns observed for dissolved arsenic groundwater plumes.

The highest concentrations of ammonia in groundwater (up to 2,710 milligrams per liter (mg/L)) were found at locations adjacent to or downgradient of the existing animal hide piles or in other areas where animal wastes have been buried, such as the NSTAR right-of-way. Consistent with the MSGRP RI, these groundwater plumes, including ammonia, migrate and discharge in the HBHA Pond. Concentrations of ammonia up to 1,380 mg/L were observed discharging in the northern portion of the HBHA Pond, and concentrations up to 1,270 mg/L were observed in the deep surface water of the HBHA Pond. The concentrations of ammonia in the shallow surface water at the HBHA Pond outlet were slightly elevated and ranged from 4.0 mg/L to 17.9 mg/L.

On July 11, 2005, EPA collected samples to evaluate background ammonia surface water conditions entering the HBHA Pond. Ammonia was not detected in surface water samples collected from Halls Brook upstream of the New Boston Street Drainway confluence. Slightly elevated ammonia concentrations (ranging from 9.97 mg/L to 12.7 mg/L) were detected in surface water upstream along the New Boston Street Drainway, Landfill Creek, and East Drainage Ditch. After surface water flow from the New Boston Street Drainway combines with Halls Brook prior to its discharge into HBHA Pond, the ammonia concentration at the outlet of Halls Brook was 2.10 mg/L or approximately 80 percent less than upstream New Boston Street Drainway, which suggests the upstream ammonia concentrations are diluted by Halls Brook prior to discharge into the HBHA Pond.

EPA has evaluated the human health and ecological risks associated with ammonia based on groundwater data presented in the MSGRP RI and groundwater and surface water data presented in the June 24 ORD Memo,. In addition, EPA evaluated potential human health risks associated with the July 2005 soil data collected between former Woburn production wells G&H. EPA applied the same risk assessment methods and approach utilized in the March 2005 MSGRP RI, and determined that the ammonia contributes to excess human health risks to future commercial workers exposed to site groundwater via inhalation exposure scenarios. EPA also determined that the surface water at the HBHA Pond contains excessive concentrations of ammonia that exceeds the National Recommended Ambient Water Quality Criteria (NRWQC) and contributes to unacceptable ecological risks to aquatic life in the HBHA Pond. As a result, EPA is identifying ammonia as an additional contaminant of concern in groundwater and surface water that also warrants action under Industri-plex OU-2.

As indicated above, ammonia is an additional compound within the previously identified contaminated groundwater plumes, which discharge into the HBHA Pond. The fate and transport of ammonia in groundwater is consistent with the fate and transport of other contaminated groundwater plumes (e.g. arsenic and benzene) presented in the MSGRP RI, where contaminated groundwater plumes originate from Industri-plex OU-1 and discharge into the HBHA Pond, impacting aquatic life in the pond. Similar to processes that are attenuating arsenic and benzene, the presence of the chemocline in the HBHA Pond serves to sequester the highest concentrations of ammonia at depth while assisting in the natural processes that convert ammonia to nitrates and nitrites in the more oxic zones of the water column.

The identification of this additional contaminant of concern does not alter the remedial alternatives selected for the June 2005 Proposed Plan, which would also adequately address ammonia concentrations. Preferred Alternative GW-2–Pond Intercept and Monitoring with Institutional Controls would incorporate ammonia and remain protective; Preferred Alternative GW-4 for the West Hide Pile, In-situ Enhanced Bioremediation, would reverse observed reducing conditions to oxidizing conditions, thereby decreasing ammonia concentrations; and Preferred Alternative HBHA-4 would also intercept ammonia plumes, continue to sequester/treat contaminants (including ammonia) below the chemocline, and further reduce contaminants below NRWQC via an appropriately designed aeration treatment system. A pre-design investigation would include monitoring for ammonia to ensure the cofferdams associated with the northern portion of the HBHA Pond are properly located to intercept the contaminated groundwater plumes, including ammonia, and the aeration treatment system is appropriately designed to reduce contaminants below NRWQC. Further pre-design studies would be implemented to ensure the aeration treatment system is properly designed, and to further evaluate ammonia background conditions.

EPA also evaluated risks for the soil samples collected between the former production wells G&H. The soil samples were analyzed for heavy metals and the concentrations detected were relatively low in all samples. EPA determined that human health risks did not exceed EPA's risk range, Feasibility Study (FS) Remedial Action Objectives (RAO), or FS Preliminary Remediation Goals (PRG).

EPA believes that the addition of ammonia as a COC does not substantially affect the overall evaluation outcome, or alter the cost, scope, or performance of the alternatives identified in the June 2005 FS and Proposed Plan.

1.0 INTRODUCTION

This report was prepared at the request of the U.S. Environmental Protection Agency (EPA) by the cooperative efforts of Tetra Tech NUS, Inc. (TtNUS) and Metcalf and Eddy, Inc. (M&E) for the United States Environmental Protection Agency (EPA) under Contract No. 68-W6-0045, Work Assignment No. 116-RICO-0107 and Contract No. 68-W6-0042, Work Assignment No. 107-RICO-0146, respectively.

The objectives of this report are to: 1) further evaluate groundwater and surface water data that were included in the March 2005 MSGRP RI (TtNUS, 2005a) and the June 24 ORD Memo, which were included in EPA's June 2005 Administrative Record; 2) present additional surface water and soil data collected subsequent to the issuance of the MSGRP RI and the June 2005 Draft Final MSGRP Feasibility Study (TtNUS, 2005b), and 3) evaluate the nature and extent, fate and transport and potential human health and ecological risks resulting from the ammonia in groundwater and surface water data, and metals in the July 2005 soil data. For contextual purposes, previously released data is included in this evaluation.

2.0 SAMPLING BACKGROUND

After further review of groundwater and surface water data collected during the MSGRP RI, EPA on July 11, 2005, conducted additional sampling of surface water in the Halls Brook Holding Area Pond (HBHA Pond) and surface water flowing into the HBHA Pond. In addition, in response to a request from the City of Woburn, EPA collected additional surface soil samples on July 12, 2005 from a potential future recreational area adjacent to the eastern edge of the Wells G&H 38-acre wetland, near the former production wells, Well G and Well H.

The following sections present the results of these sampling events as wells as previously reported sampling events in order to fully evaluate contaminant trends and potential risks.

2.1 Groundwater and Surface Water Data

Groundwater data collected during the remedial investigation as part of the Groundwater and Surface Water Investigation Plan (GSIP) included geochemical analytical parameters to be used in the evaluation of fate and transport mechanisms for metals mobilization and migration, in particular, arsenic. These secondary parameters included anions and cations, specifically, ammonia, nitrite, nitrate, phosphorous, bicarbonate, and sulfate. Other parameters included alkalinity, total suspended solids, and dissolved organic carbon. A total of 39 well locations were sampled, most at multiple depths intervals. Well locations sampled for ammonia during the MSGRP RI investigation are shown on Figure 2-1. Detailed discussions regarding each sampling event are presented in Section 2 of the MSGRP RI. The results of these analyses were originally presented in Appendix 4B of the MSGRP RI, but are also summarized in Table 2-1. The MSGRP RI was publicly released in March 2005, and was included in EPA's June 30, 2005 Administrative Record for Industri-plex OU-2.

As reported in Section 2.0 of the MSGRP RI, EPA ORD conducted a field investigation in several phases from October 1999 to September 2001 to support an assessment of arsenic contamination and migration within the Northern Study Area. The objectives of the study were to: 1) determine migration mechanisms controlling arsenic transport at Industri-plex OU-1 and the study area; 2) evaluate the potential role of natural attenuation processes in mitigating arsenic transport from the site and study area; and 3) provide guidance for determining reasonable, cost-effective treatment technologies for the Aberjona River.

The field investigation included the collection of groundwater, surface water, and sediment samples from Industri-plex OU-1 and study area. Sample collection efforts focused on characterization of arsenic migrating from site groundwater to the surface water and sediment in the HBHA Pond. Details of the field investigation, study methodology, and results were presented in the study report (*Draft Project Report: Natural Attenuation Study; Groundwater, Surface Water, Soil, and Sediment Investigation; Industri-plex Superfund Site; Woburn, Massachusetts.* Robert Ford, EPA ORD, September 2004), which was included as Appendix 2D of the MSGRP RI. The report however, did not present all geochemical data collected during the investigation, but rather focused on the analytical results controlling arsenic migration and natural attenuation processes.

The June 24 ORD Memo presented the results of dissolved ammonia-nitrogen, temperature, and pH in groundwater and surface water samples collected during the study, including sample location figures. Well locations that were sampled by EPA ORD for ammonia are shown on Figure 2-2 (groundwater) and Figures 2-3 and 2-4 (surface water). The June 24 ORD Memo is included in Appendix A of this report, and was also included in EPA's June 30, 2005 Administrative Record for Industri-plex OU-2.

2.2 July 2005 Surface Water Data

Upon further review of the geochemistry data for groundwater and surface water data, ammonia was identified as a potential contaminant of concern due to the high concentrations observed in groundwater in the vicinity of the hide piles, the NSTAR right-of-way, and in deep surface water of the HBHA Pond; a known discharge zone for groundwater originating from the Industri-plex Site.

On July 11, 2005, EPA's New England Regional Laboratory (NERL) collected 12 surface water grab samples from 12 locations in the HBHA Pond, Halls Brook, East Drainage Ditch, New Boston Street Drainway, and Landfill Creek. Sample locations are shown on Figure 2-5. The purpose of these samples was to evaluate background concentrations of ammonia in surface water.

Samples were analyzed for ammonia, bromide, chloride, fluoride, nitrate, nitrite, sulfate, nitrate as nitrogen, nitrite as nitrogen, and o-phosphate as phosphorous. Results of these analyses as

well as field logs and sample location figures are presented in Appendix B of this report and are summarized in Table 2-4.

2.3 July 2005 Soil Data

As mentioned above, in response to a request from the City of Woburn, on July 12, 2005, EPA NERL collected 12 surface soil samples from 12 locations along the eastern edge of the Wells G&H wetland in an area potentially used for future recreational activities such as recreation trails. Sample locations are shown on Figure 2-6.

Samples were analyzed for target analyte list (TAL) metals. These results of these analyses as well as field logs and sample location figures are also presented in Appendix B of this report. Analytical results for the soil samples are also summarized in Table 2-5.

3.0 NATURE AND EXTENT OF CONTAMINATION AND FATE AND TRANSPORT

The following section presents a discussion of the analytical data for groundwater, surface water, and soil discussed above as well as fate and transport mechanisms.

3.1 Groundwater

A portion of the groundwater samples collected during the GSIP phase of the RI investigations was analyzed for anions and cations. Of particular note was ammonia, which showed concentrations ranging from non-detect in locations near Mishawum Road to 2,710 milligrams per liter (mg/L) in sample locations adjacent to or downgradient of the hide piles or where animal waste have been buried, such as the NSTAR right-of-way.

Groundwater data collected by EPA ORD showed ammonia concentrations up to 1,380 mg/L discharging in the northern portion of the HBHA Pond (TW-01 sampled on 9/11/01). The highest concentrations of ammonia were consistently observed in wells located along the northeastern edge of the HBHA Pond Refer to Figure 3-1.

The pattern of contamination shown on Figure 3-1 is consistent with the pattern predicted from both the source information and groundwater flow directions presented in the MSGRP RI. The flow path pattern is also consistent with the distribution of other contaminants modeled in the MSGRP RI, specifically, arsenic and benzene. See Figure 3-2 for a partial summary of key groundwater contaminant migration pathways, including ammonia.

Fate and Transport of Ammonia in Soil and Groundwater

Industri-plex OU-1 has a very large source of organic nitrogen in the form of buried animal hide wastes. As bacteria decompose the waste, some of the nitrogen that was bound up in complex organic molecules can be released to the soil as ammonia. Through leaching processes, the ammonia is converted to ammonium by reacting with water. Ammonia exists in water in two forms: as ammonium ion (NH_4^+), which is highly soluble, and as ammonia gas (NH_3) (Masters, 1991).

In aerobic substrates, organic nitrogen may mineralize to ammonium, which plants and microbes can utilize, adsorb to negatively charged particles (e.g., clay), or diffuse to the surface. Ammonium can be absorbed by plants or microbes and incorporated back into the organic matter matrices. It can also become bound to organic soil matrices since the soils have negative charges and the ammonium is positive. However, ammonium is a reduced compound, so if there is no oxygen present, it won't transform or be converted, but rather just increase in concentration. In the case of Industri-plex OU-1, reduced conditions have been documented in groundwater (MSGRP, 2005a). These conditions would tend to cause ammonium to remain in the dissolved state and migrate with the groundwater flow towards the south, discharging into the HBHA Pond and wetlands.

Concentrations of ammonia in groundwater can fluctuate depending on seasonal temperature conditions that impact biological activity. For example, in winter months, biological activity is usually low, consequently ammonia concentrations are low. However, the animal hide wastes at the Industri-Plex site are buried, in some cases more than 40 feet below grade, and are relatively insulated from the effects of seasonal temperature changes. Therefore, the biological processes accounting for the production of ammonia is relatively unaffected by seasonal temperature changes. This results in consistent elevated concentrations of ammonia in groundwater, discharging to the deeper portions of the HBHA Pond on a year-round basis.

3.2 Surface Water

According to the EPA ORD data from surface water samples collected in the HBHA Pond, the highest concentrations of ammonia were consistently detected at the deepest locations in the northern portion of the HBHA Pond, up to 1,270 mg/L (NML sampled on 9-14-01). The northern portion of the HBHA Pond has been identified as the principal discharge zone for contaminated groundwater originating from the Industri-plex OU-1. Concentrations of ammonia become attenuated in the water column, with concentrations decreasing towards the surface, away from the groundwater discharge zone. The concentration of ammonia in shallow water (upper 100 cm) in the HBHA Pond ranged from 2.0 mg/L to 31.1 mg/L, and averaged 10,7 mg/L. This trend of the highest concentrations at depth and lower concentrations near the surface is also consistent with other contaminants observed in surface water such as arsenic and benzene.

The concentration of ammonia from six samples collected at the Halls Brook inlet ranged from 3.3 mg/L to 7.8 mg/L over multiple sampling events from 2000 to 2004, and averaged 5.6 mg/L. The concentrations of ammonia in the six shallow surface water at the HBHA Pond outlet ranged from 4.0 mg/L to 17.9 mg/L during these multiple sampling events, and averaged 9.9 mg/L.

On July 11, 2005, EPA collected samples to evaluate background ammonia surface water conditions entering the HBHA Pond. Ammonia was not detected in surface water samples collected from Halls Brook upstream of the New Boston Street Drainway confluence. Slightly elevated ammonia concentrations, ranging from 9.97 mg/L to 12.7 mg/L, were detected in surface water upstream along the New Boston Street Drainway, East Drainage Ditch, and Landfill Creek (see Figure 2-1). After surface water flow from the New Boston Street Drainway combines with Halls Brook prior to its discharge into HBHA Pond (see Figure 2-5), the ammonia concentration at the outlet of Halls Brook was 2.10 mg/L or approximately 80 percent less than upstream New Boston Street Drainway, which suggests the upstream ammonia concentrations are diluted by Halls Brook prior to discharge into the HBHA Pond. In addition, a sample collected from the NSTAR drainage channel exhibited ammonia concentrations of 8.03 mg/L. This drainage channel discharges into the northern portion of the HBHA Pond.

Fate and Transport of Ammonia in Surface Water

The MSGRP RI has documented the presence of a chemocline in the HBHA Pond. Section 5 of the MSGRP RI presents detailed discussions on the formation and chemical reactions taking place at the chemocline. Generally, the chemocline is induced by the difference in low conductivity/oxic surface water contributed by Halls Brook and inputs of high conductivity/anoxic contaminated groundwater into the deeper portions of the pond.

Due to the chemocline, dissolved metals in groundwater are being partially sequestered at depth in HBHA Pond sediments. This chemocline also supports the biodegradation of benzene that is also being discharged by the contaminated groundwater plumes. As a result of the chemocline, high concentrations of dissolved arsenic, benzene and conductivity are detected in deeper portions of the pond's surface water, while very low concentrations are in the shallow surface water. Based on the surface water data collected by EPA ORD during the natural attenuation study, EPA has concluded that the chemocline is also serving to sequester the

ammonia at depth. See Figure 3-2 for a contaminant cross-section of HBHA Pond, including ammonia.

As ammonia diffuses towards the chemocline, the bacteria *Nitrosomonas europea* can oxidize the ammonia to nitrite. Other bacteria, such as *Nitrobacter* can then convert the nitrite to nitrate. Plants or microorganisms can assimilate nitrate (assimilatory nitrate reduction) or facultative anaerobic bacteria may further reduce nitrate (denitrification) to gaseous nitrogen (N_2) when nitrate diffuses into the deeper anoxic water of the HBHA Pond. The gaseous nitrogen can volatilize and disperse into the ambient air or be absorbed into organic matrices. Thus, the alternating reduced and oxidized conditions of the HBHA Pond both below and at the chemocline completes the nitrogen cycle.

Another biodegradation process includes direct utilization of ammonia by plankton within the water column. This process would also contribute to the decrease in ammonia concentrations observed between the upper and deeper layers of the water column. Upon the cyclical death of planktonic cells, these solids can settle back to the sediment layer returning sequestered nitrogen (ammonia) to the bottom of the HBHA Pond. Similar to the processes described at the hide piles, bacteria can decompose the plankton biomass and release the available nitrogen as ammonia.

Typically, the biological and chemical process of nitrification/denitrification in the nitrogen cycle transforms the majority of nitrogen entering wetlands, causing between 70% and 90% to be removed (Reilly 1991; Gilliam 1994). In the case of the HBHA Pond, the chemocline sequesters the higher ammonia concentrations at depth and assists the natural processes available that convert some of the ammonia to nitrates, nitrites, and nitrogen gas. As ammonia migrates to the chemocline, aerobic bacteria can convert the ammonia to nitrite. Through diffusion, the nitrite comes into contact with the more oxygenated zone of the chemocline where it can be further oxidized to nitrate. Further reductions can also occur through facultative anaerobic bacteria where the nitrate can be reduced to nitrite and nitrogen gas can be released.

Based on data collected during the 18-month surface water investigation (presented in Appendix 2C of the MSGRP RI), Halls Brook contributes approximately 50 percent of the water in the HBHA Pond (on average) during baseflow conditions and approximately 81 percent (on average) during storm events. The surface water inflows from Halls Brook also assist in

decreasing ammonia concentrations in the shallow surface water of HBHA Pond through dilution. This is most apparent during and immediately following heavy storm events.

3.3 Soil

Twelve surface soil samples were collected along the eastern edge of the Wells G&H wetland. Arsenic was the only contaminant of concern identified in the MSGRP RI that presented a risk or hazard to humans resulting from exposure to contaminated sediments. Although not posing a risk or hazard, other contaminants of potential concern (COPC) evaluated in the MSGRP RI included lead and chromium.

Arsenic was not detected in any of the 12 surface soil samples collected during the July 2005 event. Chromium concentrations ranged from 8.4 mg/kg to 26 mg/kg. Lead concentrations ranged from 52 mg/kg to 370 mg/kg.

4.0 RISK EVALUATION

This section presents a human health and ecological risk evaluation of the groundwater, surface water, and soil data presented and discussed in Sections 2.0 and 3.0. The purposes of this risk evaluation are: 1) to evaluate the potential human health risks and/or adverse ecological effects that may be posed by ammonia in groundwater and surface water at Industri-plex OU-1 and HBHA Pond, and metals in surface soil at the potential recreation trail area (RC area) near former production wells G and H; and 2) to provide a basis for decisions as to whether remedial action is necessary.

Based on the lack of a completed exposure pathway between groundwater and ecological receptors, the groundwater ammonia data have been quantitatively evaluated for human exposures only. Surface water ammonia data have been qualitatively evaluated for both human exposures and potential ecological effects. Because the RC area surface soil metals data were specifically collected at the request of the City of Woburn to evaluate an upland area being considered for future re-use as a recreation trail, a quantitative human health risk evaluation was performed for the soil data.

The human health evaluation of groundwater, surface water, and soil data is presented in Section 4.1 and the ecological evaluation of surface water data is presented in Section 4.2. For those media and chemicals associated with a human health risk or hazard above EPA risk management guidelines or exceedances of ecological benchmarks or standards (e.g., National Recommended Water Quality Criteria), Remedial Action Objectives (RAOs) and Preliminary Remediation Goals (PRGs) are presented in Section 4.3.

4.1 Human Health Risk Evaluation

The human health risk evaluation has been conducted using methods and assumptions consistent with those used in the baseline human health risk assessments for Operable Units 3 of the Wells G&H Superfund Site (Aberjona River Study; MSGRP Southern Study Area) (M&E, 2004) and Operable Unit 2 of the Industri-plex Superfund Site (MSGRP Northern Study Area) (TtNUS, 2005). In cases where quantitative evaluation was performed, only Reasonable Maximum Exposure (RME) estimates of risk and hazard have been presented.

The human health evaluation includes a quantitative evaluation of GSIP groundwater ammonia data, EPA ORD and July 2005 shallow surface water ammonia data collected from HBHA Pond, and July 2005 surface soil data. Other groundwater and surface water quality parameters measured have not been included in this evaluation because: (1) the parameter was not detected (e.g., bromide); (2) detected concentrations were significantly below conservative screening criteria (e.g., nitrate, nitrite, and fluoride); or (3) the parameter is a nutrient/dietary component and is unlikely to be toxic at the levels detected (e.g., phosphate and chloride).

Appendix C.1, Table 1 (Selection of Exposure Pathways) identifies the exposure media, exposure points, receptors, and routes of exposure quantitatively and qualitatively evaluated as part of this human health risk evaluation.

Groundwater

During the GSIP investigation, transect sampling of groundwater was conducted in 2001/2002 for Industri-plex OU-1 and the study area which included sampling and analysis for ammonia. The groundwater ammonia data quantitatively evaluated for human health risks are presented in Appendix C.2, Table 1. Sampling locations are shown on Figure 2-1.

Based on the MADEP groundwater use and value determination (MADEP, 1997), residential groundwater use in the Industri-plex Site area is assumed not to occur in the future. However, use of contaminated groundwater for commercial purposes (e.g., process water and use in a car wash) is assumed. Based on information presented in the baseline human health risk assessment for the Northern Study Area (TtNUS, 2005a), the car wash scenario is more conservative than the process water scenario for volatile compounds. Therefore, this risk evaluation only presents the car wash scenario results. For the car wash scenario, inhalation of volatile compounds released from groundwater would be the primary exposure pathway.

To evaluate the impact of future groundwater use in a car wash on indoor air quality, the maximum detected groundwater ammonia concentration presented in Appendix C.3, Table 1, was modeled to an indoor air concentration using methods and assumptions provided in Appendix C.3, Table 2. For estimation of air concentrations in a warm water car wash, the shower model approach presented by Foster and Chrostowski (1986; 1987) was assumed to be

proportionally representative of conditions similar to a car wash. Additional details concerning the methods and assumptions used in the modeling are provided in Appendix C.3.

The maximum modeled indoor air ammonia concentration is presented in Appendix C.1, Table 2.1. The maximum modeled air concentration was compared to ambient air PRGs published by USEPA Region 9 (USEPA, 2004). PRGs are chemical concentrations back-calculated using toxicity criteria and either a 1×10^{-6} target risk level for potential carcinogens or a hazard quotient (HQ) of 1 for noncarcinogens. For purposes of this screening analysis, a HQ of 0.1 was used to add a ten-fold measure of safety to reduce the chance of omitting chemicals from the list of COPCs that could contribute to a total hazard index (HI) of 1. To accomplish this, PRGs for noncarcinogenic chemicals (i.e., ammonia) were divided by 10 prior to comparison to maximum detected values. Because the maximum modeled indoor air concentration exceeded the ambient air PRG, ammonia was selected as an indoor air COPC for the car wash scenario.

Groundwater ammonia data were then used to generate a groundwater 95% Upper Confidence Limit (UCL) value (Appendix C.3, Table 3) which was then modeled to estimate an airborne 95% UCL concentration a worker may be exposed to during water use in a car wash. Documentation of the 95% UCL calculation is provided in Appendix C.3, Table 4. Appendix C.3, Table 5, provides the model assumptions used to generate the 95% UCL air concentration. Appendix C.1, Table 3.1.RME lists the modeled 95% UCL air concentration for car wash water use.

The exposure parameters for the adult car wash worker are shown in Appendix C.1, Table 4.1.RME. Car wash workers are assumed to be exposed to volatile COPCs in indoor air only. For the inhalation pathway, the exposure time was assumed to be equivalent to a typical 8-hour work day (USEPA, 1997a). An exposure frequency of 250 days/year was used, which represents the 95th percentile number of days worked per year. The default high-end exposure duration of 25 years was used (USEPA, 1997a). As recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years). The equation used for the calculation of carcinogenic and noncarcinogenic intakes of ammonia is presented in Appendix C.1, Table 4.1,RME.

A chronic inhalation toxicity criterion (i.e., RfC) for ammonia was obtained from EPA's Integrated Risk Information System (IRIS) (USEPA, 2005) and is provided in Appendix C.1, Table 5.2. Because ammonia has not been classified as to carcinogenicity by EPA, no carcinogenic toxicity criteria were available for use in this evaluation (Appendix C.1, Table 6.2). A toxicity profile for ammonia is provided in Appendix E.

Risk estimation is undertaken by combining the toxicity factors and exposure assessment equations to calculate estimates of risks. Non-carcinogenic risks are reported as compound-specific hazard quotients (HQs) that are summed to provide a total receptor hazard index (HI). In general, HIs that are less than 1 are not of regulatory concern; however, a HI of greater than 1 does not automatically indicate that an adverse effect will occur and should not automatically be interpreted as posing an unacceptable risk to the exposed population.

The estimated ammonia HQ for the inhalation pathway is listed for the future car wash worker receptor exposed to ammonia in groundwater in Appendix C.1, Table 7.1. The HQ for the RME receptor exceeded the target HI of 1 (HI of 90). The highest concentrations of ammonia were seen in monitoring wells: B1-04, B5-03, W5-05, B8-04, B7-03, and B6-03.

The above groundwater risk calculations for the future car wash worker receptor exposed to ammonia are consistent with EPA's baseline risk assessment for the Northern Study Area presented in the MSGRP RI.

Surface Water

EPA ORD and July 2005 surface water ammonia data for the HBHA Pond were evaluated for potential impacts to human health. Human receptors could potentially contact ammonia in surface water while using the HBHA Pond for recreational purposes. The most likely receptor to utilize this area is a teenager (ages 12 to 18). The teenage recreational user is likely to be exposed to contaminants in surface water by dermal contact during wading. Even though the HBHA Pond has surface water of sufficient depth to support swimming, wading is likely to be the most common recreational activity. Ingestion of surface water is not quantitatively evaluated for wading since it is unlikely that teenagers would ingest more than a negligible amount of surface water during wading. Inhalation of ammonia from surface water is assumed to be negligible because the levels of this compound released from surface water would be diluted and

dispersed into ambient air. Because wading exposures would allow for contact with only shallow surface water (i.e., < 2 feet in depth), shallow surface water data presented in Appendix C.2, Table 2 have been considered in this evaluation.

Due to a lack of oral toxicity values for ammonia that could be adjusted for applicability to the dermal route of exposure, ammonia could not be quantitatively evaluated for dermal contact hazard. Instead, ammonia was qualitatively evaluated by comparison of detected concentrations in shallow surface water data to a value of 30 mg/L (Appendix C.1, Table 2.2). This value is a lifetime health advisory provided in the Drinking Water Standards on Health Advisories (USEPA, 2004b) for drinking water exposures and is specifically related to a taste threshold. A safe concentration may be higher than this value. The maximum detected shallow surface water concentration (17.2 mg/L) is below this drinking water value (30 mg/L). Therefore, ammonia in shallow surface water was not selected as a human health COPC and no further evaluation was conducted for ammonia in surface water.

Soil

Surface soil samples (0-6 inches) were collected in July 2005 at area RC, representative of the approximate location of a potential recreation trail planned by the City of Woburn. Analytical results of metals detected in individual soil samples collected from area RC are presented in Appendix C.2, Table 3. Sampling locations are shown in Figure 2-6.

Human receptors could potentially contact contaminants in surface soil while using the upland areas of the Wells G&H wetland for recreational purposes. The most likely receptors to utilize this area, which is planned for development as recreational space, include adult and young child recreational users. The recreational user is likely to be exposed to contaminants in surface soil by incidental ingestion and dermal contact. Inhalation of metals from surface soil is assumed to be negligible because the low levels of airborne particulates would be diluted and dispersed into ambient air.

Surface soil data are summarized in Appendix C.1, Table 2.3. The soil summary table provides the frequency of detection, range of detection limits, range of detected concentrations, and location of maximum detected result for each detected metal. Because hexavalent chromium

analysis was not performed, total chromium detected in surface soil is conservatively assumed to exist as hexavalent chromium.

The maximum detected concentration of each metal in soil was compared to Region 9 residential soil PRGs (USEPA, 2004) adjusted to a HQ of 0.1 for noncarcinogens. The comparison of maximum concentrations to PRGs is presented in Appendix C.1, Table 2.3. Essential human nutrients that lacked screening criteria (i.e., calcium, magnesium, iron, potassium, and sodium) were eliminated prior to the screening process. Essential nutrients are unlikely to cause substantial toxicity at concentrations commonly encountered. Copper was also eliminated since it is abundant in the earth's crust and unlikely to cause substantial toxicity at concentrations commonly encountered. Since PRGs were not available for lead, the maximum detected lead concentration was evaluated relative to the residential soil screening level of 400 mg/kg (USEPA, 1994a).

The maximum detected results for aluminum, antimony, chromium, manganese, and vanadium exceeded their respective PRGs and were selected as future surface soil COPCs. As a conservative approach, the maximum detected concentration of each surface soil COPC was used as the exposure point concentration in the quantitative evaluation. The maximum detected concentrations are presented in Appendix C.1, Table 3.2.RME. None of the COPCs identified are classified as ingestion or dermal contact carcinogens. Therefore, carcinogenic risks associated with future surface soil exposures were not estimated.

The exposure parameters for the young child recreational user scenario are shown in Appendix C.1, Table 4.2.RME. Because only non-carcinogenic hazards will be estimated for soil, the young child is the most sensitive receptor and provides the most conservative estimate of non-carcinogenic hazard. Therefore, the adult hazard estimates have not been presented. For the surface soil ingestion pathway, the default RME soil ingestion rate (200 mg/kg; USEPA, 1994b) for young child residents was used. Consistent with the Aberjona River Study human health risk assessment, it was assumed that the young child recreational user may visit the RC area and engage in activities resulting in surface soil exposure for 3 days per week for the warmest 6 months of the year (78 days/year). The fraction of surface soil ingested from the area was assumed to be 50%. Because each of the soil COPCs lacked EPA recommended dermal absorption factors, dermal exposures were not assessed. The default high-end exposure duration of 6 years and a 15 kg body weight were used (USEPA, 1994b). The averaging time

for noncarcinogens was set equal to the exposure duration (USEPA, 1989). The equations used for the calculation of non-carcinogenic intakes of metals are presented in Appendix C.1, Table 4.2.RME.

The chronic toxicity criteria were obtained from EPA's Integrated Risk Information System (IRIS) (USEPA, 2005). This source lists the most recent toxicity values recommended by USEPA for use in human health risk assessments. In the event that toxicity values for a COPC were not available through IRIS, provisional toxicity values were obtained from the Superfund Technical Support Center (STSC), a division of USEPA. Appendix C.1, Table 5.1 summarizes the oral non-carcinogenic toxicity values (i.e., RfDs) and the corresponding critical effects for the soil COPCs. As stated previously, no carcinogenic COPCs were identified in surface soil (see Appendix C.1, Table 6.1).

The estimated HI for the surface soil ingestion pathway is listed for the future young child recreational user exposed to metals in surface soil in Appendix C.1, Table 7.2. The HI for the RME receptor is 0.2, which does not exceed the target HI of 1.

The above surface soil risk calculations for future recreational receptors exposed to metals are consistent with EPA's baseline risk assessment for the Southern Study Area presented in the MSGRP RI.

4.2 Ecological Risk Evaluation

The ecological risk evaluation includes a quantitative evaluation of EPA ORD and July 2005 surface water ammonia data. Other surface water quality parameters measured have not been included in this evaluation because: (1) the parameter was not detected (e.g., bromide); (2) detected concentrations were significantly below conservative screening criteria (e.g., chloride and fluoride); or (3) the parameter is a nutrient/dietary component and is unlikely to be toxic at the levels detected (e.g., phosphate and nitrate).

Ammonia is known to be highly toxic to aquatic life including many species of fish and invertebrates in fresh water (EPA, 1999). In natural waters, ammonia primarily exists in two forms, un-ionized ammonia (NH_3) and ammonium ion (NH_4^+), which are in equilibrium with each other, and the forms present are dependent on the chemical conditions of the water, particularly

pH and temperature. These speciation relationships are important to ammonia toxicity because un-ionized ammonia is much more toxic to aquatic receptors than ammonium ion.

For the purposes of this report, the evaluation of ecological risk resulting from potential exposure to aquatic life was based on the subset of surface water data collected from the HBHA Pond. These data were compared to surface water quality benchmarks to identify potential risk to aquatic life in the pond.

The surface water data collected for HBHA Pond indicate exceedances of the National Recommended Water Quality Criteria (NRWQC) for ammonia (EPA, 2002). The NRWQC for ammonia is dependent on pH and temperature (Appendix D). The NRWQC criteria are based on both invertebrates and fish toxicity testing data. The selected criteria used for HBHA Pond, are based on the absence of sensitive fish (trout) in the habitat for the CMC (acute criteria) and the absence of fish early life stages for the CCC (chronic criterion). The CMC represents the 1-hour average concentration that is not to be exceeded more than once every 3 years, on average. The CCC represents the 30-day average concentration of total ammonia-nitrogen that is not to be exceeded more than once every 3 years. The selected CCC assumes that no early life stages of fish are likely to be present. If the ammonia CCC criteria protective of early-life stages of fish were utilized, additional areas of exceedances during lower temperature conditions would be identified because below 15 degrees centigrade (°C), the CCC values for the category “early-life stages of fish present” are lower than the CCC values calculated for the category “early life stages of fish absent” (refer to Appendix D).

Of the 165 total surface water samples presented, 125 had results for pH, temperature, and ammonia, thereby allowing for calculation of and comparison to the criteria concentrations (Table 4-1). Of the 125 samples evaluated, 84 exceeded the CCC and 39 exceeded the CMC. The majority of the exceedances occurred in deeper water. All of the exceedances of the CMC (acute criteria) occurred in samples from 4.9 feet or more in depth below the surface. The samples from the northern multi-level (NML) sampler indicated consistent ammonia CCC exceedances below a depth of 4 feet for all samples. At the HBHA Pond outlet, three of the five measured ammonia concentrations exceeded the CCC value in May 2000, August 2000, and September 2001, with measured ammonia concentrations in the surface water (0.3 feet below the surface) ranging from 8 to 17 mg/L (Table 4-1).

The EPA ORD and July 2005 surface water data from HBHA Pond indicate that there are numerous exceedances of ammonia criteria throughout the pond. These data indicate a potential risk to aquatic life from the exposure to ammonia in HBHA Pond.

4.3 Impact of Findings on RAOs and PRGs

Based on the results of the human health and ecological risk evaluations presented in Sections 4.1 and 4.2, ammonia in groundwater was determined to be associated with human health risks in excess of risk management guidelines and ammonia in surface water exceeds NRWQCs. Therefore, the current RAO for groundwater will be modified to include ammonia as follows:

- Prevent exposures associated with a HI > 1 and/or ILCR > 10^{-6} to 10^{-4} by meeting the associated PRGs for the following scenarios:
  - Vapor inhalation of benzene, trichloroethene, naphthalene, 1,2-dichloroethene, *and ammonia* by a car wash worker using groundwater in the car wash

The PRG for ammonia in groundwater, associated with a HQ of 1, is 4 mg/L. The ammonia PRG was calculated using the same methods and assumptions employed for the HQ calculation for the car wash worker exposed to ammonia in groundwater. Additional details regarding the calculation of the ammonia PRG is provided in Appendix C.3.

The current RAO for surface water will be modified to include ammonia as follows:

- Protect aquatic life from arsenic, benzene, *and ammonia* above levels indicative of impairment or provide alternate habitat in the event that HBHA Pond is used as a component of the remedy. Meet ARARs for the protection of aquatic life.

The NRWQC is the PRG for ammonia in surface water. Because the NRWQC for ammonia is pH and temperature dependent, tables and formulas provided in Appendix D should be used to calculate the appropriate value, based on site-specific pH and temperature data.

5.0 IMPACT OF FINDINGS ON THE JUNE 2005 PROPOSED PLAN

Based on an evaluation of the data presented above, a human health risk above the EPA target HI was identified due to elevated concentrations of ammonia in groundwater and an unacceptable risk to aquatic life in the HBHA Pond was identified due to the exceedances of the NRWQC for ammonia. The RAOs and PRGs for ammonia in both groundwater and surface water would be addressed by the current preferred remedial alternatives identified in the June 2005 Proposed Plan.

The remedial alternatives evaluated in the FS for groundwater included:

- *Alternative GW-1: No Action Alternative*
- *Alternative GW-2: Pond Intercept with Monitoring and Institutional Controls*
- *Alternative GW-3: Plume Intercept by Groundwater Extraction, Treatment and Discharge and Monitoring with Institutional Controls*
- *Alternative GW-4: Plume Intercept by In-Situ Groundwater Treatment and Monitoring with Institutional Controls*

With the addition of ammonia as a COC, the technical applicability of Alternative GW-4: Plume Intercept by In-Situ Groundwater Treatment and Monitoring with Institutional Controls may be further compromised since it is highly uncertain that a reactive wall material exists that is effective for removing ammonia However, Preferred Alternative GW-4 for the West Hide Pile, In-situ Enhanced Bioremediation, would reverse observed reducing conditions to oxidizing conditions, thereby decreasing ammonia concentrations associated with the West Hide Pile. Based on the evaluation criteria presented in the FS, the addition of ammonia as a COC does not substantially affect the overall evaluation outcome for the groundwater alternatives.

The current preferred groundwater remedy identified in the June 2005 Proposed Plan is *Alternative GW-2 - Pond Intercept with Monitoring and Institutional Controls*. Alternative GW-2 protects human health by preventing or controlling potential exposures to contaminated groundwater through institutional controls. GW-2 also includes conducting long-term monitoring of the groundwater, surface water, and sediments to evaluate the status and migration of contaminants and the effectiveness of the remedy. This alternative, coupled with *Alternative HBHA-4 -Storm Water Bypass, Sediment Retention, Partial Dredging and Restoration, and*

Monitoring, also decreases the downstream migration of contaminated groundwater by intercepting it at the northern portion of the HBHA Pond where natural attenuation processes decrease contaminant concentrations.

Alternative HBHA-4 divides HBHA Pond into two main areas using a system of cofferdams. The southern portion of the HBHA Pond would be dredged to remove contaminated sediments and restored. The northern portion of the Pond would be incorporated into the cleanup plan as a sediment retention basin. It would be used to intercept contaminated groundwater, and maintain a chemocline in the surface water to degrade and sequester contaminants in the deep portions of the pond (chemocline is a transition layer which separates the more contaminated deep surface water from the less contaminated shallow surface water). Between the first and second low-head cofferdams, an aeration treatment system would be designed to further decrease contaminants of concern (e.g. precipitation, biological degradation/transformation, volatilization).

The alternatives presented in the June 2005 Proposed Plan will adequately address the risks associated with ammonia in groundwater and will address both the human health and ecological RAOs. Similar to arsenic and benzene, the highest concentrations of ammonia would be sequestered in the deeper portions of the northern HBHA Pond. The design of the aeration treatment system would further decrease ammonia concentrations by promoting the conversion of ammonia to nitrites and nitrates. Monitoring parameters for Alternatives GW-2 and HBHA-4 would require modification to include analysis for ammonia in both groundwater and surface water, as well as nitrites, nitrates, pH and temperature in surface water. Since the ammonia would be concentrated in a smaller area of the HBHA Pond, a pre-design study should be conducted to determine the optimum aeration/oxygenation treatment system. In addition, the production of ammonia at the West Hide Pile would be decreased due to the oxidized conditions.

Additional pre-design surface water investigations would also be necessary to further evaluate ammonia background conditions (e.g. New Boston Street Drainway, Landfill Creek, and the East Drainage Ditch, as well as NSTAR ROW Culvert/ Drainage Ditch).

6.0 SUMMARY

Based upon further evaluation of groundwater and surface conditions and the findings presented in this Technical Memorandum, EPA is identifying ammonia as an additional contaminant of concern in groundwater and surface water for Industri-plex OU-2. In addition to the previously identified contaminants of concerns (e.g. arsenic, benzene) presented in the MSGRP RI, high concentrations of ammonia are also present in the contaminated groundwater plumes, which migrate and discharge into the HBHA Pond. These high concentrations of ammonia in the groundwater present a human health risk to future commercial workers during car wash operations. High concentrations of ammonia are also present in deep surface water of the HBHA Pond, as a result of the contaminated groundwater plumes discharge in the pond. Concentrations of ammonia in surface water of the HBHA Pond exceed NRWQC, and contribute to unacceptable ecological risks to aquatic life in the pond.

The fate and transport of ammonia is similar to the fate and transport patterns observed for dissolved arsenic groundwater plumes. The surface water data indicate that the chemocline in the HBHA Pond is effectively sequestering the highest concentrations of ammonia at depth. In addition, other natural biological, chemical, and physical attenuation processes are effectively decreasing ammonia concentrations in the water column from the deeper portions to the shallow depths prior to its discharge from the HBHA Pond.

The addition of ammonia as a contaminant of concern does not alter the preferred remedial alternatives identified in the June 2005 Proposed Plan, which would also adequately address ammonia concentrations. Preferred Alternative GW-2 – Pond Intercept and Monitoring with Institutional Controls would incorporate ammonia and remain protective; Preferred Alternative GW-4 for the West Hide Pile, In-situ Enhanced Bioremediation, would reverse observed reducing conditions to oxidizing conditions, thereby reducing ammonia concentrations; and Preferred Alternative HBHA-4 would also intercept ammonia plumes, continue to sequester/treat contaminants (including ammonia) below the chemocline, and further reduce contaminants below NRWQC via an appropriately designed aeration treatment system. Pre-design investigations would include monitoring for ammonia to ensure the cofferdams associated with the northern portion of the HBHA Pond are properly located to intercept the contaminated groundwater plumes, including ammonia, and the aeration treatment system is appropriately designed to reduce contaminants below NRWQC. Further pre-design studies would be

implemented to ensure the aeration treatment system is properly designed, and to further evaluate ammonia background conditions.

EPA also evaluated risks for the soil samples collected between the former production wells G&H. The soil samples were analyzed for heavy metals and the concentrations detected were relatively low in all samples. Based on the available data, EPA determined that human health risks did not exceed EPA's risk range, Feasibility Study (FS) Remedial Action Objectives (RAO), or FS Preliminary Remediation Goals (PRG) as presented in the FS.

EPA believes that the addition of ammonia as a COC does not substantially affect the overall evaluation outcome, or alter the cost, scope, or performance of the alternatives identified in the June 2005 FS and Proposed Plan.

TABLES

TABLE 2-1
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CB1-04-GW-01NS-110701	CB2-05-GW-02	CB2-05-GW-03R	CB2-06-GW-02NS	CB3-02-GW-01NS	CB3-02-GW-03	CB3-03-GW-03	CB4-03-GW-03	CB4-04-GW-01NS	CB4-04-GW-02NS
Sample Location	B1-04	B2-05	B2-05	B2-06	B3-02	B3-02	B3-03	B4-03	B4-04	B4-04
Date Sampled	11/7/2001	8/17/2001	8/17/2001	8/17/2001	7/9/2001	7/9/2001	7/16/2001	7/10/2001	8/16/2001	8/16/2001
Sample Elevation	70.03	53.1	43.99	62.41	60.04	55.34	39.6	19.32	55.99	45.06
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	NA	215	459	248	1500	1670	645	879	70.3	7.4
Alkalinity to pH 8.3	NA	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	NA	215	459	248	1500	1670	645	879	70.3	7.4
Carbonate (MG/L as Ca)	NA	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	923	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.070 J	0.072 UJ	0.043 UJ	0.040 UJ	0.11	0.097 J	0.040 U	0.049 UJ	0.040 UJ	0.040 UJ
Nitrite-N	0.050 J	0.034 J	0.041 J	0.075	0.015 U	0.015 U	0.015 U	0.015 U	0.041 J	0.14 J
Nitrogen, Ammonia	2150	13.3	73.0	8.51	270 J	322 J	49.5 J	156 J	2.7	1.87
Sulfate	NA	560	420	590	128	196	3.0 U	135	640	570
Total Phosphorus as PO4 water	64.7	0.56 J	0.45 J	0.46 J	1.82 J	2.1 J	1.13	0.25 J	0.74 J	9.33 J
Total Suspended Solids	NA	203	24.0	430	155	31.0	126 J	8.4 J	83.0	1200

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CB4-05-GW-03NS	CB5-01-GW-01	CB5-02-GW-02	CB5-02-GW-03	CB5-03-GW-03	CB6-03-GW-01	CB6-03-GW-02	CB6-03-GW-03	CB7-01-GW-01	CB7-01-GW-03
Sample Location	B4-05	B5-01	B5-02	B5-02	B5-03	B6-03	B6-03	B6-03	B7-01	B7-01
Date Sampled	8/31/2001	7/16/2001	7/9/2001	7/9/2001	8/16/2001	7/18/2001	7/19/2001	7/31/2001	7/17/2001	7/17/2001
Sample Elevation	41.42	54.49	52.19	44.42	36.37	55.41	49.4	39.4	50.77	-0.53
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	177	369	2710	1310	10600	1500	6720	2990	650	12.7
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	177	369	2710	1310	10600	1500	6720	2990	650	12.7
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.040 U	0.040 U	0.040 U	0.079 J	0.068 UJ	0.040 U	0.059 J	0.040 U	0.040 U	4.63
Nitrite-N	0.040 J	0.018 J	0.015 U	0.015 U	0.027 J	0.015 U	0.034 J	0.025 J	0.045 J	0.015 U
Nitrogen, Ammonia	21.9	16.3 J	720 J	281 J	2710	276	1910	859	27.4	0.13 U
Sulfate	1590	1140	211	197	1.5 U	61.0 J	5.0	2.4 J	15.0 UJ	39.0 J
Total Phosphorus as PO4 water	14.3	3.65	9.58 J	3.8 J	12.3 J	6.65	9.2	29.9	11.8	0.13 U
Total Suspended Solids	2020	64.0 J	126	74.0	4.0 J	12.0	712	3.0 U	134 J	7.6 J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CB7-02-GW-01	CB7-02-GW-02	CB7-03-GW-01	CB7-03-GW-02R	CB7-03-GW-03	CB8-01-GW-01	CB8-01-GW-0199	CB8-01-GW-01-AVG	CB8-01-GW-03	CB8-04-GW-02NS
Sample Location	B7-02	B7-02	B7-03	B7-03	B7-03	B8-01	B8-01	B8-01	B8-01	B8-04
Date Sampled	7/16/2001	7/16/2001	7/25/2001	7/25/2001	7/25/2001	7/17/2001	7/17/2001	7/17/2001	7/17/2001	7/24/2001
Sample Elevation	48.37	39.07	49.6	34.4	14.6	48.32	48.32	48.32	-6.18	26.67
QC Identifier	None	None	None	None	None	Field Dup. CB8-01-GW-01	Field Dup. CB8-01-GW-01	Field Dup. CB8-01-GW-01	None	Field Dup. CB8-04-GW-02NS
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	653	42.3	616	1330	5070	97.5	106	100	519	7560
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	653	42.3	616	1330	5070	97.5	106	100	519	7560
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.040 U	0.10 U	0.053 J	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Nitrite-N	0.105	0.051	0.015 U	0.076	0.098	0.015 U	0.015 U	0.015 U	0.040 J	0.062
Nitrogen, Ammonia	76.0 J	11.4 J	195	348	1380	4.92	5.3	5.1	73.3	2190
Sulfate	930	520	580	350	3.0 J	287 J	283 J	290	1020 J	2.0 J
Total Phosphorus as PO4 water	0.80	0.31	0.23	3.06	13.9	0.37	0.36	0.36	0.48	49.9
Total Suspended Solids	93.0 J	36.0 J	3.0 U	3.0 U	9.6 J	4.0 J	3.0 U	2.8	48.0 J	170 J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CB8-04-GW-02NS99	CB8-04-GW-02NS-AVG	CB9-01-GW-01	CB9-01-GW-03	CB9-02-GW-02	CB9-04-GW-01	CB9-05-GW-01	CE3-02-GW-03	CE4-02-GW-01	CE4-03-GW-01NS-072301
Sample Location	B8-04	B8-04	B9-01	B9-01	B9-02	B9-04	B9-05	E3-02	E4-02	E4-03
Date Sampled	7/24/2001	7/24/2001	7/10/2001	7/10/2001	7/10/2001	7/23/2001	7/23/2001	7/25/2001	7/19/2001	7/23/2001
Sample Elevation	26.67	26.67	45.29	22.59	28.09	54.55	45.46	1.49	55.48	56.21
QC Identifier	Field Dup. CB8-04-GW-02NS	Field Dup. CB8-04-GW-02NS	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	7680	7600	723	2950	929	64.5	51.3	184	1160	NA
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	NA
Bicarbonate	7680	7600	723	2950	929	64.5	51.3	184	1160	NA
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	NA
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.040 U	0.040 U	2.62	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.096 J
Nitrite-N	0.016 J	0.039	0.015 U	0.124	0.075	0.026 J	0.019 J	0.019 J	0.119	0.021 J
Nitrogen, Ammonia	2280	2200	583 J	891 J	47.0 J	3.52	2.17	0.040 U	12.2	104
Sulfate	1.8 J	1.9	240	980	3550	29.0	52.0	94.0	15.0 U	NA
Total Phosphorus as PO4 water	45.3	48.0	1.22 J	0.38 J	0.23 J	0.29	0.15 J	0.17	0.28	0.57
Total Suspended Solids	249 J	210	7.6 J	13.0	83.0	3.0 U	3.0 U	10.0 J	148	NA

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CE4-03-GW-03	CE4-03-GW-0399	CE4-03-GW-03-AVG	CH1-04-GW-04	CH1-04-GW-05R	CH2-02-GW-02	CH2-02-GW-05	CH2-04-GW-05	CH2-04-GW-06	CL2-03-GW-01
Sample Location	E4-03	E4-03	E4-03	H1-04	H1-04	H2-02	H2-02	H2-04	H2-04	L2-03
Date Sampled	7/19/2001	7/19/2001	7/19/2001	7/18/2001	7/18/2001	7/12/2001	7/12/2001	7/12/2001	7/12/2001	7/11/2001
Sample Elevation	39.91	39.91	39.91	20.92	11.62	39.56	15.26	-0.81	-11.51	46.17
QC Identifier	Field Dup. CE4-03-GW-03	Field Dup. CE4-03-GW-03	Field Dup. CE4-03-GW-03	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	356	342	350	84.1	109	43.5	109	74.4	163	17.9
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	356	342	350	84.1	109	43.5	109	74.4	163	17.9
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.51
Nitrite-N	0.026 J	0.027 J	0.026	0.027 J	0.044 J	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
Nitrogen, Ammonia	0.38	0.46	0.42	0.055 UJ	0.092 UJ	2.5 J	2.54 J	0.63 J	0.24 UJ	0.18 UJ
Sulfate	133	139	140	29.0 J	34.0 J	27.0	530	169	281	36.0
Total Phosphorus as PO4 water	0.81	0.80	0.80	3.29	0.15 J	0.18	0.15 J	0.13 U	0.13 U	0.13 U
Total Suspended Solids	12.0	14.0	13.0	931	46.0	118 J	3.6 J	46.0 J	28.0 J	7.2 J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CL2-03-GW-02	CL2-03-GW-0299	CL2-03-GW-02-AVG	CL2-05-GW-01NS	CL2-05-GW-03	CW5-03-GW-01	CW5-03-GW-02R	CW5-03-GW-02R99	CW5-03-GW-02R-AVG	CW5-03-GW-03NS
Sample Location	L2-03	L2-03	L2-03	L2-05	L2-05	W5-03	W5-03	W5-03	W5-03	W5-03
Date Sampled	7/11/2001	7/11/2001	7/11/2001	7/11/2001	7/11/2001	7/13/2001	7/13/2001	7/13/2001	7/13/2001	7/23/2001
Sample Elevation	35.27	35.27	35.27	45.67	25.87	47.15	22.35	22.35	22.35	-2.15
QC Identifier	Field Dup. CL2-03-GW-02	Field Dup. CL2-03-GW-02	Field Dup. CL2-03-GW-02	None	None	None	Field Dup. CW5-03-GW-02R	Field Dup. CW5-03-GW-02R	Field Dup. CW5-03-GW-02R	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	29.9	30.1	30.0	77.7	74.0	114	448	454	450	479
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	29.9	30.1	30.0	77.7	74.0	114	448	454	450	479
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.39	0.39	0.39	0.040 U	0.92	0.040 U	0.068 UJ	0.069 UJ	0.068 UJ	0.20 U
Nitrite-N	0.034 J	0.015 J	0.024	0.090	0.015 U	0.020 J	0.10	0.099	0.10	0.277
Nitrogen, Ammonia	0.059 UJ	0.19 UJ	0.059 UJ	11.3 J	0.11 UJ	4.0 J	71.3 J	61.5 J	66.0	249
Sulfate	27.0	30.0	29.0	15.0 U	41.0	323	1700	1700	1700	3210
Total Phosphorus as PO4 water	0.85 J	0.18 J	0.52	0.45 J	0.13 U	0.45	0.95	0.74	0.84	0.35
Total Suspended Solids	341	261	300	167	3.0 U	8.4 J	86.0 J	62.0 J	74.0	200 J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	CW5-05-GW-02R	CW5-05-GW-03	CW5-08-GW-01	P1-01-GW-01-041201	P1-01-GW-01R	P1-01-GW-02	P1-01-GW-02R	P1-01-GW-03R	P1-01-GW-04R	P1-01-GW-05R
Sample Location	W5-05	W5-05	W5-08	P1-01	P1-01	P1-01	P1-01	P1-01	P1-01	P1-01
Date Sampled	7/13/2001	7/13/2001	7/30/2001	4/12/2001	7/27/2001	4/12/2001	5/25/2001	7/20/2001	7/27/2001	8/1/2001
Sample Elevation	25.03	6.18	52.39	45.62	42.35	36.32	31.35	24.02	13.45	3.35
QC Identifier	None	None	None	None	None	None	None	None	None	Field Dup. P1-01-GW-05R
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	10400	4430	45.8	102	245	201	450	177	61.9	55.8
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	10400	4430	45.8	102	245	201	450	177	61.9	55.8
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.13 U	0.29 U	0.040 U	0.30	0.86	2.25	5.36	4.23	2.84	0.040 U
Nitrite-N	0.057	0.037 J	0.021 J	0.015 UJ	0.112	0.015 UJ	0.015 U	0.015 U	0.015 U	0.033 J
Nitrogen, Ammonia	2370 J	616 J	1.4	1.97	1.42	0.11 U	0.040 U	0.040 U	0.049 J	0.043 J
Sulfate	23.3	2030	18.2	8.3	36.0	34.3	97.0	61.0	39.0	57.0
Total Phosphorus as PO4 water	0.60	0.93	0.13 U	0.13 J	0.43	0.13 U	0.25 J	0.59	0.13 U	0.38
Total Suspended Solids	6.8 J	33.0 J	6.8 J	3.0 U	20.0	9.6 J	24.0	187	3.0 U	15.0

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	P1-01-GW-05R99	P1-01-GW-05R-AVG	P1-01-GW-06NS-110701	P1-01-GW-07NS	P1-01-GW-08NS-111301	P1-02-GW-01	P1-02-GW-02	P1-02-GW-03	P1-02-GW-04	P1-02-GW-0499
Sample Location	P1-01	P1-01	P1-01	P1-01	P1-01	P1-02	P1-02	P1-02	P1-02	P1-02
Date Sampled	8/1/2001	8/1/2001	11/7/2001	11/12/2001	11/13/2001	7/20/2001	5/25/2001	7/20/2001	7/30/2001	7/30/2001
Sample Elevation	3.35	3.35	-5.15	-15.65	-26.65	43.74	24.22	13.52	5.72	5.72
QC Identifier	Field Dup. P1-01-GW-05R	Field Dup. P1-01-GW-05R	None	None	None	None	None	None	Field Dup. P1-02-GW-04	Field Dup. P1-02-GW-04
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	58.4	57.0	61.7	33.8	64.9	235	76.6	45.3	158	160
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	58.4	57.0	61.7	33.8	64.9	235	76.6	45.3	158	160
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	14.2	5.4 U	7.2 U	NA	NA	NA	NA	NA
Nitrate	0.040 U	0.040 U	0.040 U	0.16	0.20 U	0.040 U	0.040 U	0.040 U	0.047 J	0.040 U
Nitrite-N	0.034 J	0.034	0.034 J	0.015 U	0.015 U	0.021 J	0.015 U	0.015 U	0.015 U	0.015 U
Nitrogen, Ammonia	0.059 J	0.051	0.30	0.16	0.27	8.7	19.5	8.02	0.28	0.28
Sulfate	56.0	57.0	2400 UJ	48.0 UJ	75.0 U	49.0	39.0	37.0	38.0	37.0
Total Phosphorus as PO4 water	0.37	0.38	364	26.2	36.2	1.17	0.59 J	0.27	0.17	0.23
Total Suspended Solids	20.0	18.0	211000	480	2270 J	269	104	10.8 J	14.0 J	16.0 J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	P1-02-GW-04-AVG	P1-02-GW-05NS-110501	P1-02-GW-06NS-110601	P1-02-GW-07NS	P1-03-GW-01	P1-03-GW-02	P1-03-GW-03	P1-03-GW-04	P1-03-GW-05NS	P1-03-GW-06NS-051601
Sample Location	P1-02	P1-02	P1-02	P1-02	P1-03	P1-03	P1-03	P1-03	P1-03	P1-03
Date Sampled	7/30/2001	11/5/2001	11/6/2001	11/8/2001	4/20/2001	4/20/2001	4/26/2001	4/26/2001	5/16/2001	5/16/2001
Sample Elevation	5.72	-4.78	-14.78	-22.28	46.8	40.2	29.2	18.7	9.8	-0.3
QC Identifier	Field Dup. P1-02-GW-04	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	160	147	148	134	40.3	57.0	57.6	132	85.1	93.7
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	160	147	148	134	40.3	57.0	57.6	132	85.1	93.7
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	5.3 U	5.9 U	6.6 U	NA	NA	NA	NA	NA	NA
Nitrate	0.034	0.040 U	0.040 U	0.040 U	3.88	6.64	0.040 U	0.040 U	0.040 U	0.040 U
Nitrite-N	0.015 U	0.037 J	0.028 J	0.043 J	0.025 J	0.015 U	0.015 UJ	0.015 UJ	0.020 J	0.015 UJ
Nitrogen, Ammonia	0.28	1.13	1.15	0.24	0.087 UJ	0.079 UJ	0.30 U	0.11 U	0.74	0.38
Sulfate	38.0	1400 UJ	2200 UJ	50.0 U	43.0	86.0	37.0	56.0	160	1500 J
Total Phosphorus as PO4 water	0.20	273	196	15.8	0.13 U	0.25 J	0.71	0.35	9.6	121
Total Suspended Solids	15.0	145000 J	542000	1910 J	22.0	30.0 U	155	80.0 J	18700	826000

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	P1-04-GW-01	P1-04-GW-02	P1-04-GW-0299	P1-04-GW-02-AVG	P1-04-GW-03	P1-04-GW-04	P1-05-GW-01	P1-05-GW-02	P1-05-GW-03	P1-05-GW-04NS
Sample Location	P1-04	P1-04	P1-04	P1-04	P1-04	P1-04	P1-05	P1-05	P1-05	P1-05
Date Sampled	4/20/2001	4/20/2001	4/20/2001	4/20/2001	4/24/2001	4/24/2001	4/19/2001	4/19/2001	4/25/2001	4/26/2001
Sample Elevation	54.84	44.84	44.84	44.84	35.94	23.84	39.76	30.66	24.66	12.06
QC Identifier	None	Field Dup. P1-04-GW-02	Field Dup. P1-04-GW-02	Field Dup. P1-04-GW-02	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	13.8	119	119	120	48.0	59.0	40.2	91.3	96.9	62.0
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Bicarbonate	13.8	119	119	120	48.0	59.0	40.2	91.3	96.9	62.0
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	0.64	0.15	0.15	0.15	7.87	1.05	2.54	0.24	0.042 J	0.29
Nitrite-N	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.027 J	0.028 J
Nitrogen, Ammonia	0.34	1.81	1.83	1.8	0.072 UJ	0.065 UJ	0.22 U	1.46	1.86	0.16 U
Sulfate	18.2	47.0	49.0	48.0	21.0	35.0	41.0	28.4	25.0	33.0
Total Phosphorus as PO4 water	0.20 J	0.13 U	0.13 U	0.13 U	0.13 U	0.51 J	0.13 U	0.13 U	0.13 U	26.4
Total Suspended Solids	26.0	6.0 J	5.2 J	5.6	3.2 J	159	3.0 U	3.0 U	3.0 U	4960

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-1 (cont.)
GROUNDWATER WET CHEMISTRY ANALYTICAL RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	P1-05-GW-05	P1-06-GW-01	P1-06-GW-02	P1-06-GW-03	P1-06-GW-04	P1-07-GW-01	P1-07-GW-0199	P1-07-GW-01-AVG	P1-07-GW-02	P1-07-GW-03NS-073101
Sample Location	P1-05	P1-06	P1-06	P1-06	P1-06	P1-07	P1-07	P1-07	P1-07	P1-07
Date Sampled	4/30/2001	4/13/2001	4/13/2001	4/13/2001	4/13/2001	4/18/2001	4/18/2001	4/18/2001	4/30/2001	7/31/2001
Sample Elevation	-1.34	48.12	40.62	31.12	21.12	49.82	49.82	49.82	41.82	33.32
QC Identifier	None	None	None	None	None	Field Dup. P1-07-GW-01	Field Dup. P1-07-GW-01	Field Dup. P1-07-GW-01	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere	O'Brien & Gere
Wet Chemistry Analysis (MG/L)										
Alkalinity to pH 4.5	94.8	24.0	41.9	14.5	53.2	34.3	35.4	35.0	46.3	NA
Alkalinity to pH 8.3	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	NA
Bicarbonate	94.8	24.0	41.9	14.5	53.2	34.3	35.4	35.0	46.3	NA
Carbonate (MG/L as Ca)	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	NA
Dissolved Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	1.5	3.06	5.65	3.98	3.07	1.68	1.64	1.7	0.63	NA
Nitrite-N	0.038 J	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.026 J	NA
Nitrogen, Ammonia	0.071 UJ	0.042 UJ	0.072 UJ	0.39	0.088 UJ	0.053 UJ	0.052 UJ	0.053 UJ	0.085 UJ	0.078 J
Sulfate	30.0	76.0	31.0	11.7	19.4	31.0	17.5	24.0	16.0	NA
Total Phosphorus as PO4 water	0.37	0.13 U	0.14 J	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.22	70.0
Total Suspended Solids	52.0 J	3.0 U	35.0	18.0	5.6 J	5.2 J	3.6 J	4.4	32.0 J	NA

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number		A01-1-101499	A01-2-101599	A02-1-101499	A03-1-101599	A03-2-101599	A04-1-101599	A04-2-101599	A04-3-101599	A05-1-101599	A06-1-101899	A06-2-101899
Sample Location		A01	A01	A02	A03	A03	A04	A04	A04	A05	A06	A06
Date Sampled		10/14/1999	10/15/1999	10/14/1999	10/15/1999	10/15/1999	10/15/1999	10/15/1999	10/15/1999	10/15/1999	10/18/1999	10/18/1999
Sample Elevation		53.58	44.58	61.2	65.13	55.13	59.21	49.46	41.71	65.25	62.19	52.19
QC Identifier		None	None	None	None	None	None	None	None	None	None	None
Filtered		Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source		Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis	Units											
Alkalinity	MG/L AS CA	NM	NM	1035	273	159	431	NM	233	452	738	409
Conductivity	MS/CM	3470	NM	2870	2090	818	1345	NM	NM	1330	2270	1656
DO(Chemet)	MG/L	NA	NA	NA	0.30	0.30	0.040	NA	NA	NA	0.10	0.20
DO(electrode)	MG/L	NA	NA	0.29	0.55	0.36	0.14	NA	NA	0.14	0.20	0.19
Ferrous Iron	MG/L	NM	NM	16.4	2.91	2.93	2.14	5.35	2.27	2.54	1.69	1.16
Nitrogen, Ammonia	MG/L	63.7	22.4	79.3	1.9	1.6	18.8	6.0	1.5	3.4	8.6	3.5
ORP	MV	-140	NA	-119.1	-39.5	-55.7	-140.1	NA	NA	-137.2	-148.1	-7.1
pH	S.U.	6.62	NM	6.7	6.61	6.66	6.92	NM	NM	6.72	7.27	6.26
Temperature	°C	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turbidity	NTU	>	NM	77.0	78.0	43.0	40.0	NM	NM	5.1	20.9	101

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	A07-1-101899	A07-2-101899	A08-1-101999	A08-2-101999	A08-3-101999	A09-1-101999	A09-2-101999	A10-2-102099	A10-3-102099	A11-1-102099	A11-2-102099	A11-3-102099
Sample Location	A07	A07	A08	A08	A08	A09	A09	A10	A10	A11	A11	A11
Date Sampled	10/18/1999	10/18/1999	10/19/1999	10/19/1999	10/19/1999	10/19/1999	10/19/1999	10/20/1999	10/20/1999	10/20/1999	10/20/1999	10/20/1999
Sample Elevation	64.17	54.17	47.58	37.58	17.58	43.55	33.55	35.99	25.99	45.49	35.49	25.49
QC Identifier	None	None	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis												
Alkalinity	194	148	79.0	240	1500	43.0	184	144	6460	302	6350	2100
Conductivity	854	974	296	730	5560	308	NM	5250	13220	1046	11620	11220
DO(Chemet)	0.040	NA	0.40	0.020	NA	0.30	NA	0.35	0.35	0.40	0.10	0.50
DO(electrode)	0.58	0.63	0.53	0.92	NA	0.34	NA	0.34	0.050	0.25	0.19	0.060
Ferrous Iron	1.73	1.49	2.89	1.75	8.551	0.84	2.551	1.93	1.56	1.43	0.41	1.48
Nitrogen, Ammonia	0.80	0.20	0.90	1.3	96.4	0.80	10.7	235.7	810.1	8.8	709.3	77.7
ORP	14.4	-83.7	-33.6	-47.3	-116.5	40.3	NA	-195	-260	-76.7	-155.4	-73.8
pH	6.03	6.39	6.72	6.57	7.07	6.14	NM	7.14	7.51	6.68	7.8	7.79
Temperature	NR	NR	7.5	8.1	NR	NR	11.4	11.1	11.6	NR	NR	NR
Turbidity	7.0	201	2.9	75.3	>	6.5	NM	7.3	8.9	2.5	50.0	46.1

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	A12-1-102099	A12-2-102199	A12-3-102199	A13-1-102099	A13-2-102099	A13-4-102099	A14-1-113099	A18-1-120299	A20-1-032800	A20-2-032800	A21-1-033000
Sample Location	A12	A12	A12	A13	A13	A13	A14	A18	A20	A20	A21
Date Sampled	10/20/1999	10/21/1999	10/21/1999	10/20/1999	10/20/1999	10/20/1999	11/30/1999	12/2/1999	3/28/2000	3/28/2000	3/30/2000
Sample Elevation	45.44	35.44	25.44	48.49	38.49	10.99	54.75	30	44	39	65.07
QC Identifier	None	None	None	None	None	None	None	Field Dup. A18-1-120299	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	236	404	456	65.0	12080	NM	130	53.0	130	88.0	NM
Conductivity	1456	3310	3590	242	21500	NM	524	628	428	880	264
DO(Chemet)	0.15	0.15	0.10	0.15	0.10	NA	0.15	0.50	NA	NA	NA
DO(electrode)	NA	0.13	0.020	0.42	0.040	NA	0.39	1.56	0.080	0.10	0.99
Ferrous Iron	1.99	126	15.1	1.24	0.80	NM	8.75	3.6	12.2	2.1	12.8
Nitrogen, Ammonia	16.3	14.6	18.6	1142.6	1141.8	244.2	3.4	1.2	2.0	0.90	0.80
ORP	-34	-116	-102	-18.5	-237.4	NA	1.9	58.4	-430	-470	NA
pH	6.19	6.37	6.58	6.88	8.04	NM	5.56	6.27	6.47	6.21	6.62
Temperature	12.8	11.9	12.6	NR	NR	NR	5.2	13.0	11.9	12.4	13.4
Turbidity	27.7	195	52.3	9.6	181	NM	2.9	50.4	2.2	2.5	3.4

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	A21-2-033000	A22-1-033100	A22-2-033100	A23-1-033100	A23-2-040300	Atlantic Ave.	TW01-032900	TW01-040301	TW01-051700	TW01-082300	TW01-091101
Sample Location	A21	A22	A22	A23	A23	Atlantic Ave. Drainway	TW01	TW01	TW01	TW01	TW01
Date Sampled	3/30/2000	3/31/2000	3/31/2000	3/31/2000	4/3/2000	4/5/2000	3/29/2000	4/3/2001	5/17/2000	8/23/2000	9/11/2001
Sample Elevation	57.07	64.38	59.38	64.28	57.28			39			
QC Identifier	None	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	NM	44.0	240	ND	48.0	50.0	4160	5360	5948	7628	7308
Conductivity	1464	1315	1112	1327	NM	NM	12660	13410	13430	14820	14770
DO(Chemet)	0.20	0.30	0.20	0.40	NA	7.0	NA	0.30	0.60	0.20	NA
DO(electrode)	0.22	3.38	0.68	0.24	NA	NA	0.11	0.27	0.020	4.88	0.18
Ferrous Iron	3.0	15.5	18.4	13.5	21.5	0.035 U	NM	30.75	12.5	2.35	5.3
Nitrogen, Ammonia	77.7	9.8	31.7	2.2	2.2	0.10	874	1090	1065	897	1380
ORP	NA	125.6	25.7	141.8	NA	95.0	-161	-149.9	-214	-273	-187
pH	6.88	5.53	6.24	4.64	NM	7.14	ND	7.02	7.26	7.26	7.37
Temperature	10.2	13.5	11.8	13.7	NM	11.1	11.1	7.4	14.1	20.7	23.7
Turbidity	6.3	2.8	4.7	ND	NM	NM	6.2	1.6	1.9	2.2	2.7

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	TW02-032901	TW02-040600	TW02-051600	TW02-082300	TW02-091101	TW03-032900	TW03-051600	TW03-082200	TW04-032900	TW04-032901	TW04-051600
Sample Location	TW02	TW02	TW02	TW02	TW02	TW03	TW03	TW03	TW04	TW04	TW04
Date Sampled	3/29/2001	4/6/2000	5/16/2000	8/23/2000	9/11/2001	3/29/2000	5/16/2000	8/22/2000	3/29/2000	3/29/2001	5/16/2000
Sample Elevation	34					35				34	
QC Identifier	None	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	4080	4030	4530	4440	4072	206	210	210	24.0	122	94.0
Conductivity	8410	9200	8850	9170	8630	1266	1191	989	2240	2140	2110
DO(Chemet)	NA	0.30	0.10	0.10	0.30	0.60	0.80	NA	NA	NA	NA
DO(electrode)	0.40	0.11	0.020	0.39	0.14	0.54	0.46	0.46	0.69	1.19	0.18
Ferrous Iron	0.10	0.080	0.15	0.11	0.14	ND	0.080	0.030	11.2	3.06	19.6
Nitrogen, Ammonia	1110	1260	1191	1170	1180	37.9	41.3	37.9	2.5	1.9	2.5
ORP	-137.6	-277.1	-265	-314.6	-234	267	168.5	NA	22.0	-13	-17
pH	7.67	7.56	7.72	7.44	7.39	6.06	5.95	5.97	5.94	6.73	6.19
Temperature	8.6	8.1	16.8	17.9	21.8	13.8	16.6	21.4	10.9	7.5	15.4
Turbidity	2.0	2.6	1.3	1.2	2.0	1.4	1.0	3.7	0.90	1.4	0.40

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	TW04-082300	TW04-091101	TW05-051700	TW05-082300	TW05-091301	TW06-1-040500	TW06-1-082200	TW06-2-051600	TW06-2-082200	TW06-3-040500	TW06-3-051600
Sample Location	TW04	TW04	TW05	TW05	TW05	TW06	TW06	TW06	TW06	TW06	TW06
Date Sampled	8/23/2000	9/11/2001	5/17/2000	8/23/2000	9/13/2001	4/5/2000	8/22/2000	5/16/2000	8/22/2000	4/5/2000	5/16/2000
Sample Elevation			37			43.8				33.55	
QC Identifier	None	None	None	None	Field Dup. TW05-091301	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	152	122	69.0	74.0	156	67.0	76.0	NM	37.5	22.0	32.0
Conductivity	2230	2170	6180	7000	6530	477	578	430	136	921	944
DO(Chemet)	NA	NA	0.60	0.60	NA	NA	0.80	0.30	0.80	0.30	0.20
DO(electrode)	0.85	0.87	0.39	0.70	0.54	0.97	0.17	0.25	2.07	1.12	0.15
Ferrous Iron	2.44	25.2	158.75	148	100.5	0.60	0.48	NA	0.010	1.48	1.37
Nitrogen, Ammonia	2.3	11.7	8.0	8.2	8.5	0.50	1.0	1.2	1.3	7.4	8.4
ORP	-243.5	-114	100	-162.3	70.2	130.8	130.8	271	260	210.1	195
pH	6.13	6.13	5.22	5.12	5.64	6.44	6.15	5.83	5.83	5.04	5.25
Temperature	18.7	22.8	14.1	18.9	19.7	13.1	21.9	14.1	20.5	9.8	13.7
Turbidity	0.80	1.0	2.0	1.5	1.0	31.0	10.2	0.30	1.7	35.1	0.70

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	TW06-3-082200	TW07-1-032901	TW07-1-040400	TW07-1-051600	TW07-1-082300	TW07-1-091101	TW07-2-032901	TW07-2-040500	TW07-2-051600	TW07-2-082300	TW07-2-091101
Sample Location	TW06	TW07	TW07	TW07	TW07	TW07	TW07	TW07	TW07	TW07	TW07
Date Sampled	8/22/2000	3/29/2001	4/4/2000	5/16/2000	8/23/2000	9/11/2001	3/29/2001	4/5/2000	5/16/2000	8/23/2000	9/11/2001
Sample Elevation		43.74					40.99				
QC Identifier	None	Field Dup. TW07-1-032901	None	None	None	Field Dup. TW07-1-091101	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	32.4	136	142	126	68.0	106	188	114	122	208	220
Conductivity	1019	1172	1151	1283	1374	1101	570	1293	940	1246	749
DO(Chemet)	0.80	0.40	0.060	NA	0.10	NA	0.30	0.10	0.10	0.050	NA
DO(electrode)	NA	0.83	0.28	0.31	0.66	0.86	0.73	0.19	0.060	0.40	0.80
Ferrous Iron	0.31	25.5	16.6	17.0	14.1	15.9	14.0	16.1	15.6	29.5	47.5
Nitrogen, Ammonia	9.0	5.2	5.6	4.9	5.3	7.4	7.2	4.1	5.5	5.7	27.5
ORP	224.5	54.2	44.2	9.1	-225.3	56.0	38.0	86.1	-24.5	-258.8	-33.6
pH	5.21	5.99	6.16	5.72	5.9	5.65	6.23	5.9	5.82	6.07	5.9
Temperature	18.6	8.5	13.1	16.0	15.7	17.6	7.6	12.0	13.8	17.1	18.8
Turbidity	1.3	1.0	1.1	5.0	1.7	3.7	1.73	0.70	2.0	0.90	0.60

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	TW07-3-032901	TW07-3-040500	TW07-3-051600	TW07-3-082300	TW07-3-091101	TW08-1-040301	TW08-1-040600	TW08-1-051700	TW08-1-082300	TW08-1-091001	TW08-2-051700
Sample Location	TW07	TW07	TW07	TW07	TW07	TW08	TW08	TW08	TW08	TW08	TW08
Date Sampled	3/29/2001	4/5/2000	5/16/2000	8/23/2000	9/11/2001	4/3/2001	4/6/2000	5/17/2000	8/23/2000	9/10/2001	5/17/2000
Sample Elevation	35.99					47.5					
QC Identifier	None	None	None	None	Field Dup. TW07-3-091101	None	None	None	None	Field Dup. TW08-1-091001	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	184	170	146	72.0	122	1292	2735	3060	284	2592	3.0
Conductivity	1919	2150	2130	2220	2270	3260	6.2	6240	6600	5730	58.0
DO(Chemet)	0.10	0.050	0.40	0.050	NA	0.40	0.40	0.30	NA	0.30	NA
DO(electrode)	0.80	0.17	0.28	0.40	0.40	0.74	0.35	0.080	0.29	0.20	7.08
Ferrous Iron	57.0	26.6	27.2	21.1	12.9	0.28	0.28	0.36	0.32	1.57	0.020
Nitrogen, Ammonia	18.2	14.9	16.5	19.3	8.7	405	722	851	916	797	2.4
ORP	7.9	-218.9	-53.1	-238.9	-62.9	-62.8	-262.7	-215.6	-287	-302.6	293.1
pH	6.14	6.03	5.86	6.04	5.73	8.02	8.02	7.82	7.8	7.66	5.33
Temperature	9.7	11.8	15.3	15.6	17.8	8.3	6.7	15.5	20.6	21.3	14.3
Turbidity	1.48	1.6	3.0	1.5	1.5	1.25	13.4	5.0	2.9	0.80	1.0

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	TW08-3-040301	TW08-3-040600	TW08-3-051700	TW08-3-082300	TW08-3-091001	TW10-1-040201	TW10-1-051600	TW10-1-082200	TW10-1-091201	TW10-2-040201	TW10-2-051600
Sample Location	TW08	TW08	TW08	TW08	TW08	TW10	TW10	TW10	TW10	TW10	TW10
Date Sampled	4/3/2001	4/6/2000	5/17/2000	8/23/2000	9/10/2001	4/2/2001	5/16/2000	8/22/2000	9/12/2001	4/2/2001	5/16/2000
Sample Elevation	38					54.17				49.17	
QC Identifier	None	None	None	None	None	None	None	None	Field Dup. TW10-1-091201	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis											
Alkalinity	3448	2540	3232	3496	3418	33.0	134	110	156	178	204
Conductivity	11840	11070	11160	11530	11820	210	474	400	446	1362	1504
DO(Chemet)	0.20	0.30	0.30	0.60	0.20	0.40	0.20	0.20	0.30	0.20	0.30
DO(electrode)	0.29	0.22	0.16	25.1	0.54	0.42	0.13	11.22	0.64	0.61	0.27
Ferrous Iron	25.4	2.41	26.4	27.5	23.1	2.42	3.14	4.0	4.2	21.4	14.2
Nitrogen, Ammonia	303	229	220	276	365	0.90	2.3	2.0	0.40	18.0	26.8
ORP	-156.1	-196.3	-204.9	-154	-105.9	-24.1	-212.2	-281.5	-139.5	21.3	-107.3
pH	6.73	6.7	6.63	6.78	6.78	6.72	6.65	6.45	6.67	6.38	6.12
Temperature	9.8	8.1	15.9	22.1	21.3	4.2	14.8	22.0	21.5	4.9	15.4
Turbidity	4.8	97.0	29.0	8.1	7.0	2.5	29.1	0.50	0.40	12.5	37.0

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-2 (cont.)
NATURAL ATTENUATION STUDY - GROUNDWATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	TW10-2-082200	TW10-2-091201	TW10-3-040201	TW10-3-051600	TW10-3-082200	TW10-3-091201	TW11-083000	TW12-1-083000	TW12-2-083000	TW13-083000
Sample Location	TW10	TW10	TW10	TW10	TW10	TW10	TW11	TW12	TW12	TW13
Date Sampled	8/22/2000	9/12/2001	4/2/2001	5/16/2000	8/22/2000	9/12/2001	8/30/2000	8/30/2000	8/30/2000	8/30/2000
Sample Elevation			44.17				45.5	45.5	40.5	45.5
QC Identifier	None	Field Dup. TW10-2-091201	None	None	None	Field Dup. TW10-3-091201	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	210	204	260	272	288	208	77.0	170	126	56.0
Conductivity	1523	1445	1673	1705	1740	1624	968	1002	1054	686
DO(Chemet)	0.60	0.20	0.40	0.20	0.40	0.40	0.20	0.050	0.20	NA
DO(electrode)	5.04	0.25	0.68	0.18	6.69	0.33	0.60	0.14	0.22	0.21
Ferrous Iron	11.3	20.9	21.0	15.5	13.6	20.4	0.43	3.3	0.58	2.9
Nitrogen, Ammonia	24.8	27.4	31.4	35.2	34.8	33.8	1.5	0.10	0.20	1.5
ORP	-253.7	-119	-133.6	-117.9	-285.1	-104.1	153	-302	-249	-273
pH	6.04	6.25	6.46	6.24	6.26	6.25	6.14	6.28	6.25	6.28
Temperature	20.8	21.2	6.6	16.2	19.0	22.2	17.7	20.1	20.1	22.4
Turbidity	1.6	1.8	3.4	9.0	1.8	5.4	14.6	35.2	6.7	6.0

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number		Atlantic Ave. Drainway-040501	Atlantic Ave. Drainway-092004	Hall's Brook Inlet-092004	Hall's Brook Inlet-040500	Hall's Brook Inlet-040501	Hall's Brook Inlet-051800	Hall's Brook Inlet-083000	Hall's Brook Inlet-091601	HBHA Pond Outlet-040500
Sample Location		Atlantic Ave. Drainway	Atlantic Ave. Drainway	Hall's Brook Inlet	Hall's Brook Inlet	Hall's Brook Inlet	Hall's Brook Inlet	Hall's Brook Inlet	Hall's Brook Inlet	HBHA Pond Outlet
Date Sampled		4/5/2001	9/20/2004	9/20/2004	4/5/2000	4/5/2001	5/18/2000	8/30/2000	9/16/2001	4/5/2000
Sample Elevation		0	0	0						
QC Identifier		None	None	None	None	None	None	None	None	None
Filtered		Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source		Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis	**Units**									
Alkalinity	MG/L AS CA	NA	NA	NA	64.0	NM	78.8	106	66.2	80.0
Conductivity	MS/CM	NA	NA	NA	383	668	555	548	593	320
DO(Chemet)	MG/L	NA	NA	NA	6.8	6.5	NA	4.0	NA	6.1
DO(electrode)	MG/L	NA	NA	NA	11.5	NA	7.74	4.03	6.63	NA
Ferrous Iron	MG/L	NA	NA	NA	0.504	0.272	0.914	NM	0.176	0.727
Nitrogen, Ammonia	MG/L	2.2	0.70	3.3	5.2	5.5	7.8	7.6	4.1	7.4
ORP	MV	NA	NA	NA	273.3	168.9	231	264	353.6	68.1
pH	S.U.	NA	NA	NA	7.93	6.86	7.44	7.22	6.97	6.7
Temperature	°C	NA	NA	NA	11.5	11.0	14.0	19.4	15.1	12.0
Turbidity	NTU	NA	NA	NA	NM	NM	NM	9.6	3.5	NM

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	HBHA Pond Outlet-040501	HBHA Pond Outlet-051800	HBHA Pond Outlet-083000	HBHA Pond Outlet-091601	HBHA Pond Outlet-092004	WC100-040201	WC100-040400	WC100-082500	WC100-091701	WC100-113099
Sample Location	HBHA Pond Outlet	HBHA Pond Outlet	HBHA Pond Outlet	HBHA Pond Outlet	HBHA Pond Outlet	WC100	WC100	WC100	WC100	WC100
Date Sampled	4/5/2001	5/18/2000	8/30/2000	9/16/2001	9/20/2004	4/2/2001	4/4/2000	8/25/2000	9/17/2001	11/30/1999
Sample Elevation					0					
QC Identifier	None	None	None	None	None	None	None	None	None	Field Dup. WC100-113099
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	NM	81.6	NM	115.6	NA	45.2	74.0	136	132	84.0
Conductivity	710	544	760	799	NA	574	419	619	793	275
DO(Chemet)	5.5	NA	NA	NA	NA	4.0	NA	NA	NA	3.0
DO(electrode)	NA	7.67	5.38	7.6	NA	NA	7.2	3.13	6.4	3.24
Ferrous Iron	1.4	1.317	0.069	0.117	NA	0.20	0.25	0.010	0.020	NA
Nitrogen, Ammonia	6.9	8.0	16.0	17.2	4.0	5.3	7.3	15.2	17.9	9.34
ORP	78.6	216	277	374.7	NA	177.1	47.1	35.8	217.8	80.0
pH	6.76	7.14	6.95	6.73	NA	5.23	6.98	7.39	6.56	6.31
Temperature	10.9	16.0	22.6	21.6	NA	4.5	11.46	19.23	16.3	7.08
Turbidity	NM	NM	9.4	9.1	NA	4.3	7.8	11.5	9.5	8.2

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WC150-040201	WC150-040400	WC150-082500	WC150-091701	WC150-113099	WC200-040201	WC200-040400	WC200-082500	WC200-091701	WC200-113099
Sample Location	WC150	WC150	WC150	WC150	WC150	WC200	WC200	WC200	WC200	WC200
Date Sampled	4/2/2001	4/4/2000	8/25/2000	9/17/2001	11/30/1999	4/2/2001	4/4/2000	8/25/2000	9/17/2001	11/30/1999
Sample Elevation										
QC Identifier	None	Field Dup. WC150-040400	None	None	None	None	None	None	None	Field Dup. WC200-113099
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	45.8	72.0	264	266	72.0	44.0	90.0	748	512	236
Conductivity	493	419	1071	1203	276	505	438	2054	1959	688
DO(Chemet)	4.0	NA	NA	NA	3.0	4.0	NA	NA	0.10	1.0
DO(electrode)	NA	6.4	4.6	1.25	3.07	NA	4.7	0.14	1.89	1.05
Ferrous Iron	0.10	0.35	0.030	7.4	NA	0.10	0.85	17.4	21.0	0.010
Nitrogen, Ammonia	4.8	7.3	44.0	44.8	9.86	5.1	24.1	61.0	79.6	33.6
ORP	149.9	49.1	-13.1	65.5	80.4	73.5	45.9	-106.9	-56	52.3
pH	5.03	6.97	7.35	6.33	6.32	5.82	6.81	7.76	6.42	6.12
Temperature	4.8	11.52	17.74	16.5	7.11	4.9	11.05	15.23	16.5	8.05
Turbidity	4.0	7.9	27.9	44.9	8.2	4.0	17.2	110	13.5	8.1

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WC250-040201	WC250-040400	WC250-082500	WC250-091701	WC275-040400	WC300-040201	WC300-091701	WC50-040201	WC50-040400	WC50-082500
Sample Location	WC250	WC250	WC250	WC250	WC275	WC300	WC300	WC50	WC50	WC50
Date Sampled	4/2/2001	4/4/2000	8/25/2000	9/17/2001	4/4/2000	4/2/2001	9/17/2001	4/2/2001	4/4/2000	8/25/2000
Sample Elevation										
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	47.6	150	832	750	194	45.6	902	46.2	66.0	142
Conductivity	486	693	2462	2644	901	474	3075	640	418	592
DO(Chemet)	4.0	NA	0.20	NA	NA	3.5	NA	4.0	NA	NA
DO(electrode)	NA	2.9	0.10	1.98	0.50	NA	2.0	NA	7.0	4.33
Ferrous Iron	0.10	1.3	45.4	46.25	1.2	0.20	54.25	0.20	0.45	0.010
Nitrogen, Ammonia	5.1	8.0	119	115	27.3	5.2	151	5.0	7.6	14.8
ORP	45.0	48.3	-159	-128.9	20.5	31.1	-151.5	155.7	48.2	44.1
pH	6.29	6.5	8.02	6.6	6.58	6.53	6.57	5.1	7.03	7.52
Temperature	4.8	9.95	15.23	16.0	9.95	4.9	15.7	4.0	11.39	22.26
Turbidity	4.0	32.7	43.3	13.5	22.7	4.3	13.2	4.3	9.7	16.8

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WC50-091701	WC50-113099	WN100-040201	WN100-040400	WN100-082500	WN100-113099	WN150-040201	WN150-040400	WN150-082500	WN150-113099
Sample Location	WC50	WC50	WN100	WN100	WN100	WN100	WN150	WN150	WN150	WN150
Date Sampled	9/17/2001	11/30/1999	4/2/2001	4/4/2000	8/25/2000	11/30/1999	4/2/2001	4/4/2000	8/25/2000	11/30/1999
Sample Elevation										
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	100	72.0	52.7	78.0	141	70.0	53.7	80.0	128	130
Conductivity	785	274	740	413	644	279	758	415	832	331
DO(Chemet)	NA	3.0	4.0	NA	NA	3.0	5.0	NA	NA	3.0
DO(electrode)	6.93	3.29	NA	7.0	2.77	3.58	NA	6.8	2.01	2.89
Ferrous Iron	0.010	0.030	0.60	0.45	0.99	0.020	0.60	0.65	2.16	NA
Nitrogen, Ammonia	16.4	9.36	5.5	7.4	14.7	9.87	6.0	7.5	15.5	17.0
ORP	219.4	80.4	76.2	132.3	33.3	103.2	75.7	85.1	15.5	101.1
pH	6.58	6.34	6.13	6.95	7.28	6.32	6.16	7.02	7.16	6.22
Temperature	16.4	7.07	4.1	10.82	18.54	7.14	4.1	10.87	17.76	7.29
Turbidity	8.8	10.2	4.6	9.8	14.5	7.9	4.0	8.1	35.6	16.2

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WN175-040400	WN180-082500	WN200-040201	WN200-040400	WN200-082500	WN200-113099	WN225-040400	WN250-040201	WN250-040400	WN270-040201
Sample Location	WN175	WN180	WN200	WN200	WN200	WN200	WN225	WN250	WN250	WN270
Date Sampled	4/4/2000	8/25/2000	4/2/2001	4/4/2000	8/25/2000	11/30/1999	4/4/2000	4/2/2001	4/4/2000	4/2/2001
Sample Elevation										
QC Identifier	None	None	None	Field Dup. WN200-040400	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	NM	444	53.7	82.0	682	254	78.0	57.2	1316	55.9
Conductivity	420	1544	758	426	1527	800	452	1255	3590	1340
DO(Chemet)	NA	0.30	4.0	NA	0.20	1.0	NA	4.0	NA	3.0
DO(electrode)	6.7	0.13	NA	6.7	0.090	1.45	3.5	NA	0.485	NA
Ferrous Iron	0.35	9.7	0.60	0.50	2.12	0.050	0.90	0.80	>	1.0
Nitrogen, Ammonia	8.2	68.8	6.4	8.0	132	42.5	8.4	7.0	99.1	6.8
ORP	72.3	-66.4	74.6	78.3	-44.6	48.0	48.0	-19.5	-118.2	-36.1
pH	7.04	7.37	6.16	7.05	7.2	6.08	6.96	6.71	7.19	6.46
Temperature	10.87	15.29	4.1	10.89	14.28	9.44	10.91	4.4	10.83	4.6
Turbidity	8.1	136	4.2	7.7	55.2	47.3	7.8	4.4	5.7	4.7

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WN300-040400	WN310-040201	WN50-040201	WN50-040400	WN50-082500	WN50-113099	WS100-040201	WS100-040400	WS100-082900	WS100-091701
Sample Location	WN300	WN310	WN50	WN50	WN50	WN50	WS100	WS100	WS100	WS100
Date Sampled	4/4/2000	4/2/2001	4/2/2001	4/4/2000	8/25/2000	11/30/1999	4/2/2001	4/4/2000	8/29/2000	9/17/2001
Sample Elevation										
QC Identifier	Field Dup. WN300-040400	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	2380	360.9	50.5	74.0	168	96.0	47.6	68.0	204	140
Conductivity	7650	2300	623	412	600	275	504	429	875	864
DO(Chemet)	NA	0.40	5.5	NA	NA	3.0	4.5	NA	NA	NA
DO(electrode)	0.295	NA	NA	7.1	3.74	3.72	NA	5.7	0.80	15.08
Ferrous Iron	>	35.0	0.45	0.050	0.14	0.020	0.10	NA	0.030	0.040
Nitrogen, Ammonia	597	95.5	5.4	7.4	13.1	9.5	5.1	8.3	31.1	24.0
ORP	-199.5	-40.1	104.8	135	59.6	115.2	52.2	45.2	20.5	155.3
pH	7.51	6.5	6.34	6.79	7.12	6.32	6.17	6.87	6.58	6.69
Temperature	10.44	6.4	4.1	10.83	19.0	7.07	5.3	10.92	19.3	16.8
Turbidity	9.7	39.1	8.2	11.5	11.4	11.4	4.2	9.6	8.1	40.6

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WS100-092004	WS100-113099	WS150-040201	WS150-040400	WS150-082900	WS150-091701	WS150-092004	WS150-113099	WS200-040201	WS200-040400
Sample Location	WS100	WS100	WS150	WS150	WS150	WS150	WS150	WS150	WS200	WS200
Date Sampled	9/20/2004	11/30/1999	4/2/2001	4/4/2000	8/29/2000	9/17/2001	9/20/2004	11/30/1999	4/2/2001	4/4/2000
Sample Elevation	0						0			
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	NA	110	46.4	78.0	370	178	NA	92.0	46.0	82.0
Conductivity	NA	275	491	439	1190	980	NA	275	481	452
DO(Chemet)	NA	3.0	4.0	NA	NA	0.30	NA	NA	4.0	NA
DO(electrode)	NA	3.15	NA	5.8	2.12	3.01	NA	2.76	NA	5.3
Ferrous Iron	NA	0.010	0.10	NA	0.040	0.16	NA	NA	0.10	0.25
Nitrogen, Ammonia	2.2	9.54	5.1	8.8	60.3	38.0	2.4	9.57	5.1	9.1
ORP	NA	79.8	37.3	50.4	11.7	139	NA	80.2	25.3	55.1
pH	6.28	6.3	6.43	6.78	6.61	6.37	6.18	6.29	6.63	6.7
Temperature	15.9	6.99	5.2	10.78	18.57	16.4	14.19	7.01	5.4	10.4
Turbidity	NA	9.9	4.2	7.7	8.0	56.3	NA	9.0	4.2	12.0

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WS200-082900	WS200-091701	WS200-092004	WS240-082900	WS250-040201	WS250-040400	WS250-091701	WS300-040201	WS300-040400	WS300-091701
Sample Location	WS200	WS200	WS200	WS240	WS250	WS250	WS250	WS300	WS300	WS300
Date Sampled	8/29/2000	9/17/2001	9/20/2004	8/29/2000	4/2/2001	4/4/2000	9/17/2001	4/2/2001	4/4/2000	9/17/2001
Sample Elevation			0							
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	708	524	NA	836	47.0	134	706	45.6	1500	822
Conductivity	2209	2112	NA	2483	489	696	2537	489	2333	2798
DO(Chemet)	0.20	0.10	NA	0.20	3.5	NA	0.10	3.5	NA	0.050
DO(electrode)	0.12	1.04	NA	0.27	NA	0.71	1.7	NA	0.21	1.66
Ferrous Iron	15.3	27.2	NA	38.5	0.10	NA	60.5	0.10	NM	74.0
Nitrogen, Ammonia	103	90.6	2.4	119	5.1	12.7	112	5.1	80.5	117
ORP	-158	-66	NA	-210.5	16.5	47.9	-112.1	16.5	-131.1	-159.6
pH	7.21	6.5	6.23	7.31	6.72	6.39	6.65	6.78	7.12	6.79
Temperature	15.99	16.8	14.15	15.08	5.2	9.31	16.0	5.2	8.98	15.2
Turbidity	72.4	13.0	NA	23.8	4.8	17.1	15.1	4.0	28.7	16.2

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-3 (cont.)
NATURAL ATTENUATION STUDY - SURFACE WATER WET CHEMISTRY DATA
DRAFT FINAL TECHNICIAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Sample Number	WS300-092004	WS350-092004	WS400-092004	WS50-040201	WS50-040400	WS50-082900	WS50-091701	WS50-092004	WS50-113099	NML-10-040501
Sample Location	WS300	WS350	WS400	WS50	WS50	WS50	WS50	WS50	WS50	NML
Date Sampled	9/20/2004	9/20/2004	9/20/2004	4/2/2001	4/4/2000	8/29/2000	9/17/2001	9/20/2004	11/30/1999	4/5/2001
Sample Elevation	0	0	0					0		
QC Identifier	None	None	None	None	None	None	None	None	None	None
Filtered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Data Source	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)	Robert Ford (EPA)
Wet Chemistry Analysis										
Alkalinity	NA	NA	NA	47.6	68.0	128	116	NA	76.0	7420
Conductivity	NA	NA	NA	491	420	644	809	NA	275	14350
DO(Chemet)	NA	NA	NA	4.0	NA	NA	NA	NA	3.0	NA
DO(electrode)	NA	NA	NA	NA	5.5	3.27	7.6	NA	3.9	NA
Ferrous Iron	NA	NA	NA	0.10	NA	0.020	0.010	NA	NA	NR
Nitrogen, Ammonia	2.3	4.4	104	5.3	7.9	16.0	15.1	2.0	9.58	1980
ORP	NA	NA	NA	99.0	31.5	66.7	159.3	NA	80.9	-5.2
pH	6.33	6.26	6.87	6.2	6.99	6.75	6.66	6.42	6.29	7.49
Temperature	14.12	14.09	14.9	5.1	11.61	20.47	17.0	16.72	6.99	10.1
Turbidity	NA	NA	NA	4.3	8.3	7.7	11.1	NA	21.4	NR

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
R - Rejected; NA - Not Analyzed; * - From dilution analysis

TABLE 2-4
JULY 11, 2005 SURFACE WATER SAMPLING RESULTS
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

	SAMPLE ID											
Analyte (mg/L)	**CULV-01**	**COMB-01**	**OUTLET-01**	**185NB-HALLS-01**	**185NB-RR01**	**LANDFILL-LF01**	**LANDFILL-LF02**	**LANDFILL-RR02**	**RR03**	**RR04**	**HALLS-22MAPLE-01**	**HALLS-20THIRD-01**
Ammonia-Nitrogen	8.03	2.10	3.81	ND	9.97	12.70	11.00	11.30	10.80	0.28	ND	ND
Bromide	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50
Chloride	40	103*	83*	104*	105*	130*	131*	112*	86*	92*	108*	105*
Fluoride	ND<0.50	ND<0.50	ND<0.50	ND<0.50	0.6	ND<0.50	ND<0.50	0.6	1.1	ND<0.50	ND<0.50	ND<0.50
Nitrate	5.9	3.6	2.4	2.6	7.2	2.7	4.0	5.6	4.1	3.0	2.9	2.2
Nitrite	0.15	ND<0.10	ND<0.10	ND<0.10	0.21	0.24	0.39	0.18	ND<0.10	ND<0.10	ND<0.10	ND<0.10
Sulfate	24	23	31	12	61*	38	39	58*	85*	24	12	11
Nitrate (N)	1.3	0.81	0.54	0.59	1.6	0.61	0.90	1.3	0.93	0.68	0.65	0.50
Nitrite (N)	0.05	ND<0.03	ND<0.03	ND<0.03	0.06	0.07	0.12	0.05	ND<0.03	ND<0.03	ND<0.03	ND<0.03
o-Phospate (P)	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03	ND<0.03

* Estimated value, outside calibration curve
ND = Not Detected
ND<0.50 = Not Detected at a reporting limit of 0.50 mg/L
Note: For clarity, the prefix "IP" has been removed from sample ID's.

TABLE 2-5
JULY 12, 2005 SOIL SAMPLING RESULTS
WELLS G&H WETLAND
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

	Sample ID											
Analyte (mg/Kg)	**RC-01**	**RC-02**	**RC-03**	**RC-04**	**RC-05**	**RC-06**	**RC-07**	**RC-08**	**RC-09**	**RC-10**	**RC-11**	**RC-12**
Aluminum	4600	9100	9000	3800	8300	3100	2900	5400	3100	13000	2200	7400
Antimony	ND<9.8	ND<15	ND<16	ND<16	ND<12	ND<10	ND<11	ND<13	ND<10	ND<11	12	ND<9.7
Arsenic	ND<20	ND<30	ND<32	ND<32	ND<24	ND<20	ND<22	ND<26	ND<20	ND<23	ND<20	ND<19
Barium	56	48	48	40	37	21	13	73	40	17	7	30
Beryllium	ND<0.98	ND<1.5	ND<1.6	ND<1.6	ND<1.2	ND<1.0	ND<1.1	ND<1.3	ND<1.0	ND<1.1	ND<0.99	ND<0.97
Cadmium	ND<2.9	ND<4.5	ND<4.8	ND<4.8	ND<3.2	ND<3.1	ND<3.3	ND<3.9	ND<3.0	ND<3.4	ND<3.0	ND<2.9
Calcium	2300	8000	3700	4800	9400	720	98	6000	5400	440	130	2700
Chromium	13	21	26	17	22	17	3.7	12	12	16	8.4	18
Cobalt	11	4.7	5	ND<4.8	3.9	ND<3.1	ND<3.3	7.6	ND<3.0	4.6	ND<3.0	21
Copper	20	29	79	22	21	16	4	21	19	17	11	26
Iron	5700	13000	20000	7800	7700	4300	2900	6400	6700	7300	3600	17000
Lead	69	140	240	250	370	280	52	200	240	190	160	55
Magnesium	830	900	690	370	620	150	69	1000	360	690	85	3100
Manganese	1600	94	33	24	23	9.3	3.8	37	33	24	6.4	790
Nickel	9.5	11	11	ND<9.6	7.3	6.2	ND<6.6	11	6.6	7.2	ND<5.9	14
Potassium	ND<390	ND<600	ND<640	ND<640	490	ND<410	ND<440	530	ND<400	ND<460	ND<400	520
Selenium	ND<9.8	ND<15	ND<16	ND<16	ND<12	ND<10	ND<11	ND<13	ND<10	ND<11	ND<9.9	ND<9.7
Silver	ND<2.9	ND<4.5	ND<4.8	ND<4.8	ND<3.6	ND<3.1	ND<3.3	ND<3.9	ND<3.0	ND<3.4	ND<3.0	ND<2.9
Sodium	ND<200	ND<300	ND<320	640	ND<240	ND<200	ND<220	ND<260	ND<200	ND<230	ND<200	ND<190
Thallium	ND<20	ND<30	ND<32	ND<32	ND<24	ND<20	ND<22	ND<26	ND<20	ND<40	ND<20	ND<40
Vanadium	14	36	48	24	37	28	9.5	18	21	40	28	24
Zinc	53	79	57	45	41	23	5.8	64	56	33	17	84

* Estimated value, outside calibration curve
ND<15 = Not Detected at a reporting limit of 15 mg/Kg
Note: For clarity, the prefix "IP" has been removed from sample ID's.

TABLE 4-1
COMPARISON OF AMMONIA RESULTS TO WATER QUALITY CRITERIA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Location	Date	Depth[1] (cm)	Depth[1] (ft)	Temp. °C	pH	NH3-N mg N/L	NRWQC[2] CCC	NRWQC[2] CMC
WN50	11/30/1999	50	1.6	7.07	6.32	9.5	11.0	52
WN100	11/30/1999	100	3.3	7.14	6.32	9.87	10.9	52
WN150	11/30/1999	150	4.9	7.29	6.22	17	**10.9**	53
WN200	11/30/1999	200	6.6	9.44	6.08	42.5	**9.6**	54
WN250	11/30/1999	250	8.2	11.53	6.49	NM	NA	NA
WN260	11/30/1999	260	8.5	NM	NM	NM	NA	NA
WC50	11/30/1999	50	1.6	7.07	6.34	9.36	11.0	51
WC100	11/30/1999	100	3.3	7.08	6.31	9.34	11.0	52
WC150	11/30/1999	150	4.9	7.11	6.32	9.86	11.0	52
WC200	11/30/1999	200	6.6	8.05	6.12	33.6	**10.5**	54
WC250	11/30/1999	250	8.2	9.7	6.49	NM	NA	NA
WS50	11/30/1999	50	1.6	6.99	6.29	9.58	11.1	52
WS100	11/30/1999	100	3.3	6.99	6.3	9.54	11.1	52
WS150	11/30/1999	150	4.9	7.01	6.29	9.57	11.1	52
WS200	11/30/1999	200	6.6	9.3	6.21	NM	NA	NA
WS250	11/30/1999	250	8.2	9.54	6.45	NM	NA	NA
WS300	11/30/1999	320	10	10.16	6.84	NM	NA	NA
WN50	4/4/2000	50	1.6	10.83	6.79	7.4	8.0	42
WN100	4/4/2000	100	3.3	10.82	6.95	7.4	7.6	38
WN150	4/4/2000	150	4.9	10.87	7.02	7.5	**7.4**	35
WN175	4/4/2000	175	5.7	10.87	7.04	8.2	**7.3**	35
WN200	4/4/2000	200	6.6	10.89	7.05	8	**7.3**	34
WN225	4/4/2000	225	7.4	10.91	6.96	8.4	**7.5**	37
WN250	4/4/2000	250	8.2	10.83	7.19	99.1	**6.8**	**30**
WN300	4/4/2000	300	9.8	10.44	7.51	597	**5.6**	**20**
WC50	4/4/2000	50	1.6	11.39	7.03	7.6	**7.1**	35
WC100	4/4/2000	100	3.3	11.46	6.98	7.3	**7.2**	37
WC150	4/4/2000	150	4.9	11.52	6.97	7.3	**7.2**	37
WC200	4/4/2000	200	6.6	11.05	6.81	24.1	**7.8**	42
WC250	4/4/2000	250	8.2	9.95	6.5	8	8.9	49
WC275	4/4/2000	275	9.0	9.95	6.58	27.3	**8.8**	47
WC300	4/4/2000	300	9.8	9.6	7.35	NM	NA	NA
WS50	4/4/2000	50	1.6	11.61	6.99	7.9	**7.1**	36
WS100	4/4/2000	100	3.3	10.92	6.87	8.3	**7.8**	40
WS150	4/4/2000	150	4.9	10.78	6.78	8.8	**8.0**	43
WS200	4/4/2000	200	6.6	10.4	6.7	9.1	**8.4**	45
WS250	4/4/2000	250	8.2	9.31	6.39	12.7	**9.4**	51
WS300	4/4/2000	300	9.8	8.98	7.12	80.5	**8.0**	**32**
WS340	4/4/2000	340	11	8.94	7.33	NM	NA	NA

TABLE 4-1 (cont.)
COMPARISON OF AMMONIA RESULTS TO WATER QUALITY CRITERIA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Location	Date	Depth[1] (cm)	Depth[1] (ft)	Temp. °C	pH	NH3-N mg N/L	NRWQC[2] CCC	NRWQC[2] CMC
WN50	8/25/2000	50	1.6	19	7.12	13.1	**4.2**	32
WN100	8/25/2000	100	3.3	18.54	7.28	14.7	**3.9**	27
WN150	8/25/2000	150	4.9	17.76	7.16	15.5	**4.4**	31
WN180	8/25/2000	180	5.9	15.29	7.37	68.8	**4.6**	**24**
WN200	8/25/2000	200	6.6	14.28	7.2	132	**5.4**	**30**
WC50	8/25/2000	50	1.6	22.26	7.52	14.8	**2.6**	19
WC100	8/25/2000	100	3.3	19.23	7.39	15.2	**3.5**	23
WC150	8/25/2000	150	4.9	17.74	7.35	44	**4.0**	**25**
WC200	8/25/2000	200	6.6	15.23	7.76	61	**3.1**	**13**
WC250	8/25/2000	240	7.9	15.23	8.02	119	**2.2**	**8**
WS50	8/29/2000	50	1.6	20.47	6.75	16	**4.3**	43
WS100	8/29/2000	100	3.3	19.3	6.58	31.1	**4.8**	47
WS150	8/29/2000	150	4.9	18.57	6.61	60.3	**5.0**	**47**
WS200	8/29/2000	200	6.6	15.99	7.21	103	**4.9**	**29**
WS240	8/29/2000	240	7.9	15.08	7.31	119	**4.8**	**26**
WN50	4/2/2001	50	1.6	4.1	6.34	5.4	11.0	51
WN100	4/2/2001	100	3.3	4.1	6.13	5.5	11.2	54
WN150	4/2/2001	150	4.9	4.1	6.16	6	11.2	54
WN200	4/2/2001	200	6.6	4.1	6.16	6.4	11.2	54
WN250	4/2/2001	250	8.2	4.4	6.71	7	10.4	44
WN270	4/2/2001	270	8.9	4.6	6.46	6.8	10.9	50
WN310	4/2/2001	310	10	6.4	6.5	95.5	**10.8**	**49**
WC50	4/2/2001	50	1.6	4	5.1	5	11.5	58
WC100	4/2/2001	100	3.3	4.5	5.23	5.3	11.5	58
WC150	4/2/2001	150	4.9	4.8	5.03	4.8	11.5	58
WC200	4/2/2001	200	6.6	4.9	5.82	5.1	11.4	56
WC250	4/2/2001	250	8.2	4.8	6.29	5.1	11.1	52
WC300	4/2/2001	300	9.8	4.9	6.53	5.2	10.8	48
WS50	4/2/2001	50	1.6	5.1	6.2	5.3	11.1	53
WS100	4/2/2001	100	3.3	5.3	6.17	5.1	11.2	53
WS150	4/2/2001	150	4.9	5.2	6.43	5.1	10.9	50
WS200	4/2/2001	200	6.6	5.4	6.63	5.1	10.6	46
WS250	4/2/2001	250	8.2	5.2	6.72	5.1	10.4	44
WS300	4/2/2001	300	9.8	5.2	6.78	5.1	10.2	43
WC50	9/17/2001	50	1.6	16.4	6.58	16.4	**5.8**	47
WC100	9/17/2001	100	3.3	16.3	6.56	17.9	**5.9**	48
WC150	9/17/2001	150	4.9	16.5	6.33	44.8	**6.0**	52
WC200	9/17/2001	200	6.6	16.5	6.42	79.6	**5.9**	**50**
WC250	9/17/2001	250	8.2	16	6.6	115	**6.0**	**47**

TABLE 4-1 (cont.)
COMPARISON OF AMMONIA RESULTS TO WATER QUALITY CRITERIA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Location	Date	Depth[1] (cm)	Depth[1] (ft)	Temp. °C	pH	NH3-N mg N/L	NRWQC[2] CCC	NRWQC[2] CMC
WC300	9/17/2001	300	9.8	15.7	6.57	151	**6.1**	**47**
WC320	9/17/2001	320	10	15.6	6.72	NM	NA	NA
WS50	9/17/2001	50	1.6	17	6.66	15.1	**5.5**	46
WS100	9/17/2001	100	3.3	16.8	6.69	24	**5.6**	45
WS150	9/17/2001	150	4.9	16.4	6.37	38	**6.0**	51
WS200	9/17/2001	200	6.6	16.8	6.5	90.6	**5.7**	**49**
WS250	9/17/2001	250	8.2	16	6.65	112	**5.9**	**46**
WS300	9/17/2001	300	9.8	15.2	6.79	117	**6.0**	**42**
WS330	9/17/2001	330	11	14.7	7.17	NM	NA	NA
WS50	9/20/2004	50	1.6	16.72	6.42	2	5.8	50
WS100	9/20/2004	100	3.3	15.9	6.28	2.2	6.2	52
WS150	9/20/2004	150	4.9	14.19	6.18	2.4	7.0	53
WS200	9/20/2004	200	6.6	14.15	6.23	2.4	7.0	53
WS300	9/20/2004	300	9.8	14.12	6.33	2.3	7.0	52
WS350	9/20/2004	350	11	14.09	6.26	4.4	7.0	52
WS400	9/20/2004	400	13	14.9	6.87	104	**6.0**	**40**
Hall's Brook Inlet	4/5/2000	10	0.33	11.5	7.93	5.2	**3.2**	10
	5/18/2000	10	0.33	14	7.44	7.8	**4.7**	22
	8/30/2000	10	0.33	19.4	7.22	7.6	**3.9**	29
	4/5/2001	10	0.33	11	6.86	5.5	7.7	40
	9/16/2001	10	0.33	15.1	6.97	4.1	5.7	37
	9/20/2004	10	0.33	NM	NM	3.3	NA	NA
Atlantic Ave. Drainway	4/5/2000	10	0.33	11.1	7.14	0.1	6.9	32
	5/18/2000	10	0.33	NM	NM	NM	NA	NA
	8/24/00, A	10	0.33	16.7	6.33	NM	NA	NA
	8/24/00, B	10	0.33	18.2	5.94	NM	NA	NA
	4/5/2001	10	0.33	NM	NM	2.2	NA	NA
	9/20/2004	10	0.33	NM	NM	0.7	NA	NA
HBHA Pond Outlet	4/5/2000	10	0.33	12	6.7	7.4	7.6	45
	5/18/2000	10	0.33	16	7.14	8	**5.0**	32
	8/30/2000	10	0.33	22.6	6.95	16	**3.6**	38
	4/5/2001	10	0.33	10.9	6.76	6.9	8.0	43
	9/16/2001	10	0.33	21.6	6.73	17.2	**4.1**	44
	9/20/2004	10	0.33	NM	NM	4	NA	NA
NML-1	4/5/2001	69	2.3	NM	NM	NM	NA	NA
	4/10/2001	69	2.3	11.8	6.18	NM	NA	NA
	5/14/2001	69	2.3	14.1	6.63	12.2	**6.7**	46
	9/14/2001	69	2.3	15.8	6.25	17.2	**6.3**	53
	9/21/2004	69	2.3	NM	NM	NM	NA	NA

TABLE 4-1 (cont.)
COMPARISON OF AMMONIA RESULTS TO WATER QUALITY CRITERIA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Location	Date	Depth[1] (cm)	Depth[1] (ft)	Temp. °C	pH	NH3-N mg N/L	NRWQC[2] CCC	NRWQC[2] CMC
NML-2	4/5/2001	119	3.9	9.5	6.53	8.2	9.2	48
	4/10/2001	119	3.9	10.5	6.15	NM	NA	NA
	5/14/2001	119	3.9	13.6	6.54	16.1	**7.0**	48
	5/31/2001	119	3.9	15.6	6.44	NM	NA	NA
	9/14/2001	119	3.9	16.1	6.31	14.9	**6.1**	52
	9/21/2004	119	3.9	NM	NM	NM	NA	NA
NML-3	4/5/2001	169	5.5	NM	NM	NM	NA	NA
	4/10/2001	169	5.5	11.4	6.28	NM	NA	NA
	5/14/2001	169	5.5	13.9	6.21	21.3	**7.1**	53
	9/14/2001	169	5.5	16.4	5.23	18.3	**6.3**	58
	9/21/2004	169	5.5	NM	NM	NM	NA	NA
NML-4	4/5/2001	219	7.2	9.4	6.53	9.9	**9.2**	48
	4/10/2001	219	7.2	10.9	6.54	NM	NA	NA
	5/14/2001	219	7.2	14.2	6.24	42.6	**7.0**	53
	9/14/2001	219	7.2	16.3	6.11	80.3	**6.2**	**54**
	9/21/2004	219	7.2	NM	NM	NM	NA	NA
NML-5	4/5/2001	269	8.8	9.9	6.42	63.2	**9.1**	**50**
	4/10/2001	269	8.8	10.6	6.71	NM	NA	NA
	5/14/2001	269	8.8	14.1	6.54	323	**6.8**	**48**
	9/13/2001	269	8.8	22.9	6.68	449	**3.8**	**45**
	9/21/2004	269	8.8	NM	NM	NM	NA	NA
NML-6	4/5/2001	319	10	9.6	6.64	297	**8.9**	**46**
	4/10/2001	319	10	10.6	6.56	NM	NA	NA
	5/14/2001	319	10	14.8	6.81	817	**6.2**	**42**
	5/31/2001	319	10	15.2	7.03	NM	NA	NA
	9/13/2001	319	10	23.9	6.84	1050	**3.4**	**41**
	9/21/2004	319	10	16	6.98	933	**5.4**	**37**
NML-7	4/5/2001	369	12	9.9	7.14	1170	**7.5**	**32**
	4/10/2001	369	12	11.3	6.62	NM	NA	NA
	5/14/2001	369	12	14.8	6.73	1180	**6.3**	**44**
	9/13/2001	369	12	24.8	6.73	1160	**3.3**	**44**
	9/21/2004	369	12	16.8	6.93	1110	**5.2**	**38**
NML-8	4/5/2001	419	14	10.4	6.86	1150	**8.1**	**40**
	4/10/2001	419	14	10.7	6.68	NM	NA	NA
	5/14/2001	419	14	16.4	6.74	1230	**5.6**	**44**
	9/13/2001	419	14	27.5	6.79	1270	**2.7**	**42**
	9/21/2004	419	14	17.9	6.83	1100	**5.0**	**41**

TABLE 4-1 (cont.)
COMPARISON OF AMMONIA RESULTS TO WATER QUALITY CRITERIA
DRAFT FINAL TECHNICAL MEMORANDUM
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Location	Date	Depth[1] (cm)	Depth[1] (ft)	Temp. °C	pH	NH3-N mg N/L	NRWQC[2] CCC	NRWQC[2] CMC
NML-9	4/5/2001	469	15	NM	NM	1100	NA	NA
	4/10/2001	469	15	NM	NM	NM	NA	NA
	5/14/2001	469	15	NM	NM	1890	NA	NA
	9/14/2001	469	15	NM	NM	2050	NA	NA
	9/21/2004	469	15	NM	NM	NM	NA	NA
NML-10	4/5/2001	519	17	10.1	7.49	1980	**5.8**	**20**
	4/10/2001	519	17	12.7	7.28	NM	NA	NA
	5/14/2001	519	17	15.9	7.09	2100	**5.2**	**33**
	9/13/2001	519	17	21.3	7.46	2110	**2.9**	**21**
	9/21/2004	519	17	18.6	7.14	1670	**4.3**	**32**
IP-OUTLET-01	7/11/2005	NA	NA	23.3	6.98	3.81	**3.4**	37

Notes

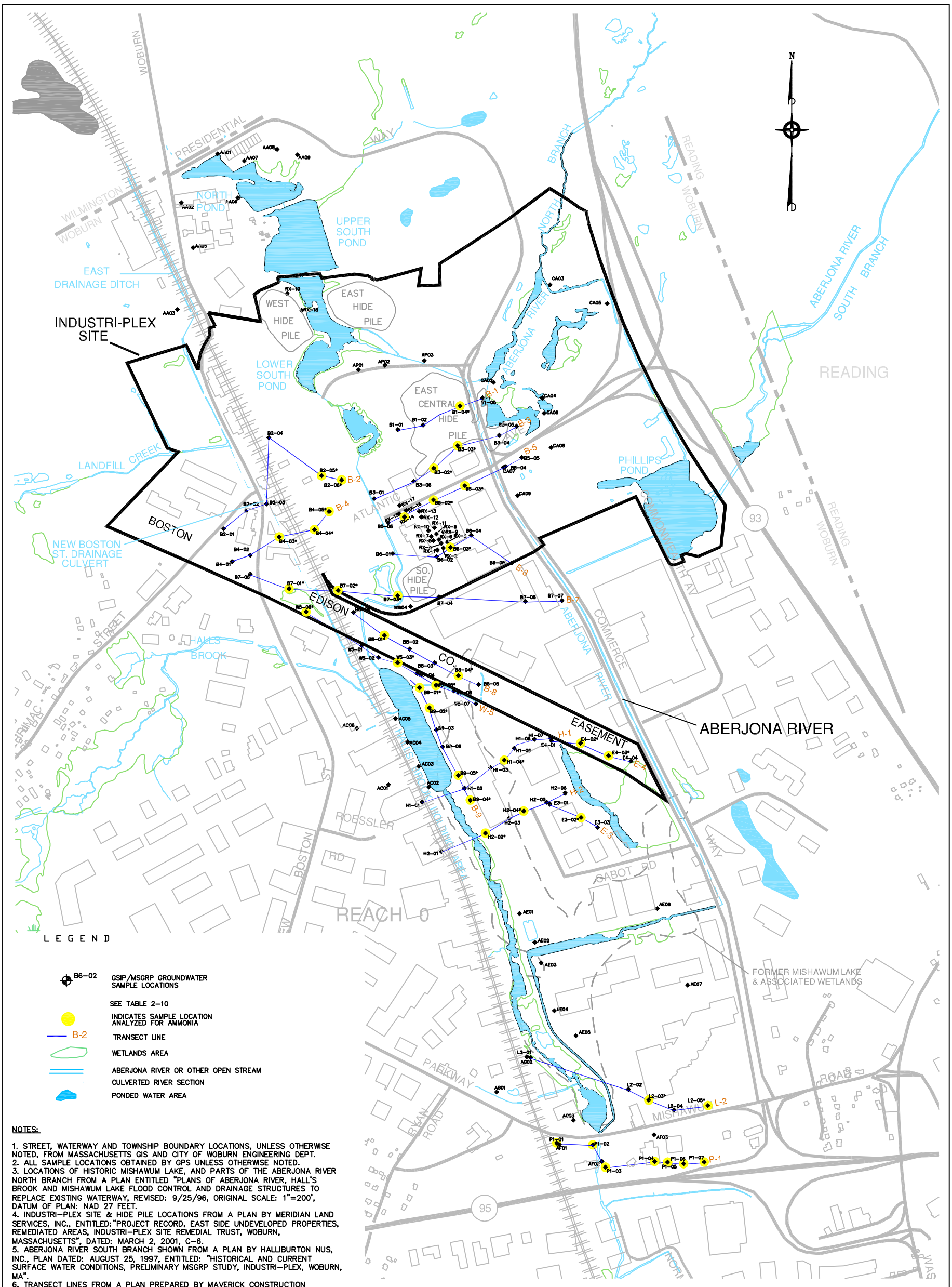
1. Depth for NML samples is screen depth, while other depths are sonde depths.

2. NRWQC - National Recommended Water Quality Criteria (EPA, 2004) for CMC (acute criteria for salmonid fish not present) and CCC (chronic criteria for fish early life stages absent) adjusted for pH and temperature.

Boldface criteria were exceeded by sample results.

NA = not applicable
ND = not detected
NS = not sampled
NM = not measured

FIGURES



NOTES:

1. STREET, WATERWAY AND TOWNSHIP BOUNDARY LOCATIONS, UNLESS OTHERWISE NOTED, FROM MASSACHUSETTS GIS AND CITY OF WOBURN ENGINEERING DEPT.
2. ALL SAMPLE LOCATIONS OBTAINED BY GPS UNLESS OTHERWISE NOTED.
3. LOCATIONS OF HISTORIC MISHAWUM LAKE, AND PARTS OF THE ABERJONA RIVER NORTH BRANCH FROM A PLAN ENTITLED "PLANS OF ABERJONA RIVER, HALL'S BROOK AND MISHAWUM LAKE FLOOD CONTROL AND DRAINAGE STRUCTURES TO REPLACE EXISTING WATERWAY, REVISED: 9/25/96, ORIGINAL SCALE: 1"=200', DATUM OF PLAN: NAD 27 FEET.
4. INDUSTRI-PLEX SITE & HIDE PILE LOCATIONS FROM A PLAN BY MERIDIAN LAND SERVICES, INC., ENTITLED:"PROJECT RECORD, EAST SIDE UNDEVELOPED PROPERTIES, REMEDIATED AREAS, INDUSTRI-PLEX SITE REMEDIAL TRUST, WOBURN, MASSACHUSETTS", DATED: MARCH 2, 2001, C-6.
5. ABERJONA RIVER SOUTH BRANCH SHOWN FROM A PLAN BY HALLIBURTON NUS, INC., PLAN DATED: AUGUST 25, 1997, ENTITLED: "HISTORICAL AND CURRENT SURFACE WATER CONDITIONS, PRELIMINARY MSGRP STUDY, INDUSTRI-PLEX, WOBURN, MA".
6. TRANSECT LINES FROM A PLAN PREPARED BY MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC. & MERIDIAN LAND SERVICES, INC., AMHERST, NH, ENTITLED: "PLANIMETRIC WORKSHEET, INDUSTRI-PLEX SITE REMEDIAL TRUST, SITE BASEMAP, INDUSTRI-PLEX SITE REMEDIAL TRUST, WOBURN, MASSACHUSETTS", SCALE: 1"= 300', DATED: SEPTEMBER 29, 2000.
7. PLAN COORDINATES IN NAD 83 FEET; ALL LOCATIONS (IF NECESSARY) CONVERTED FROM ORIGINAL DATUM TO NAD 83 FEET USING BLUE MARBLE GEOGRAPHIC CALCULATOR SOFTWARE (VERSION 4.2).
8. PLAN NOT TO BE USED FOR DESIGN.
9. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
10. THE WATERWAY BOUNDARIES SHOWN MAY NOT REPRESENT THE LIMITS OF THE WATERWAYS AT THE TIME OF SAMPLING DUE TO SEASONAL VARIATIONS IN WATERWAY BOUNDARIES AND POTENTIAL ERRORS IN WATERWAY MAPPING.
11. REFER TO EPA OFFICE OF RESEARCH & DEVELOPMENT, JUNE 24, 2005, MEMORANDUM FOR ADDITIONAL AMMONIA GROUNDWATER DATA.

GROUNDWATER SAMPLE LOCATIONS ANALYZED FOR AMMONIA

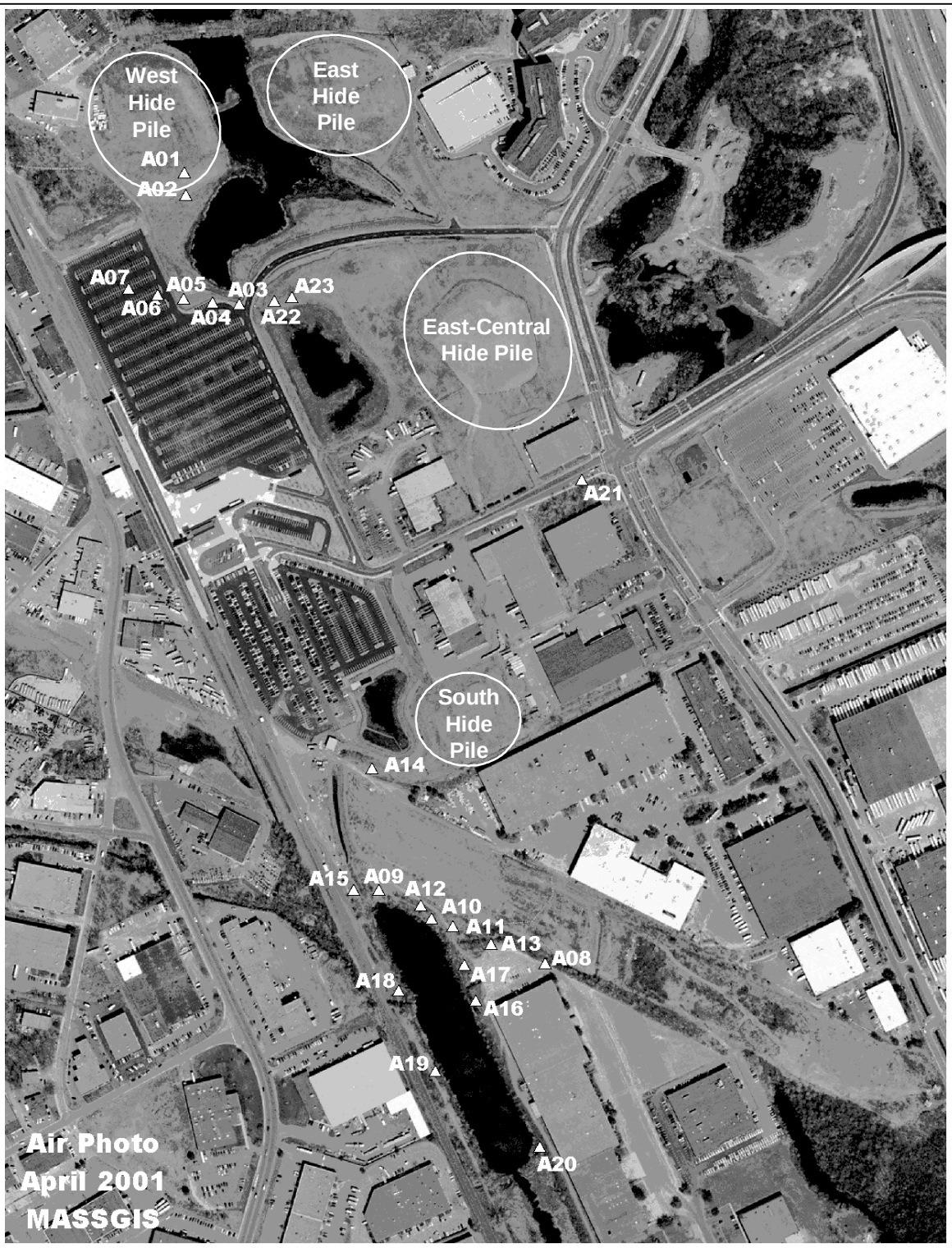
TECHNICAL MEMORANDUM – SUPPLEMENTAL DATA

INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS

FIGURE 2-1

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	G. BULLARD	DATE:	OCTOBER 17, 2005
SCALE:	AS SHOWN	FILE NO.:	\4123\1340\GW_AREA_0A_REV.DWG

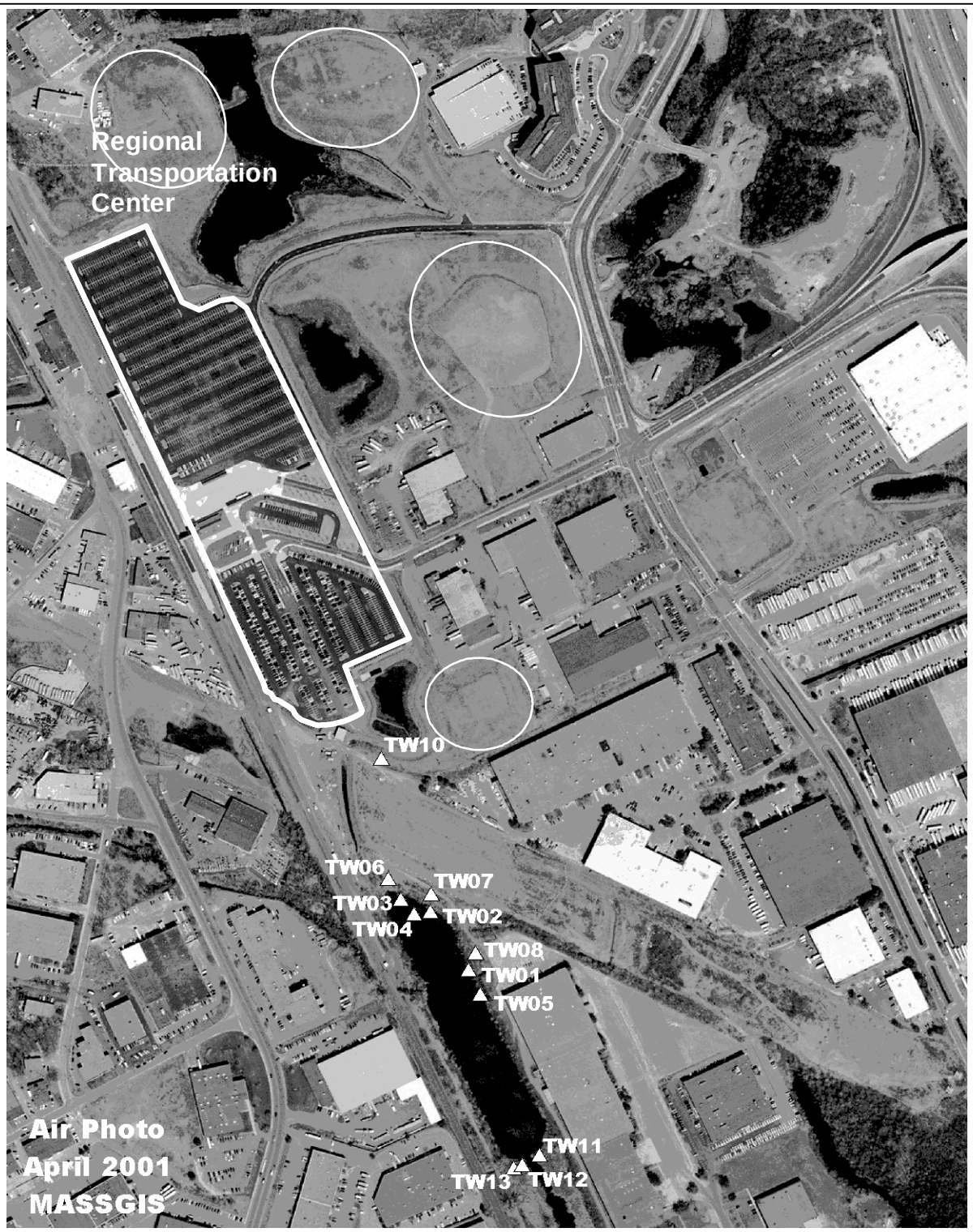
TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899



SOURCE: JUNE 24, 2005 MEMORANDUM FROM ROBERT FORD, EPA/ORD

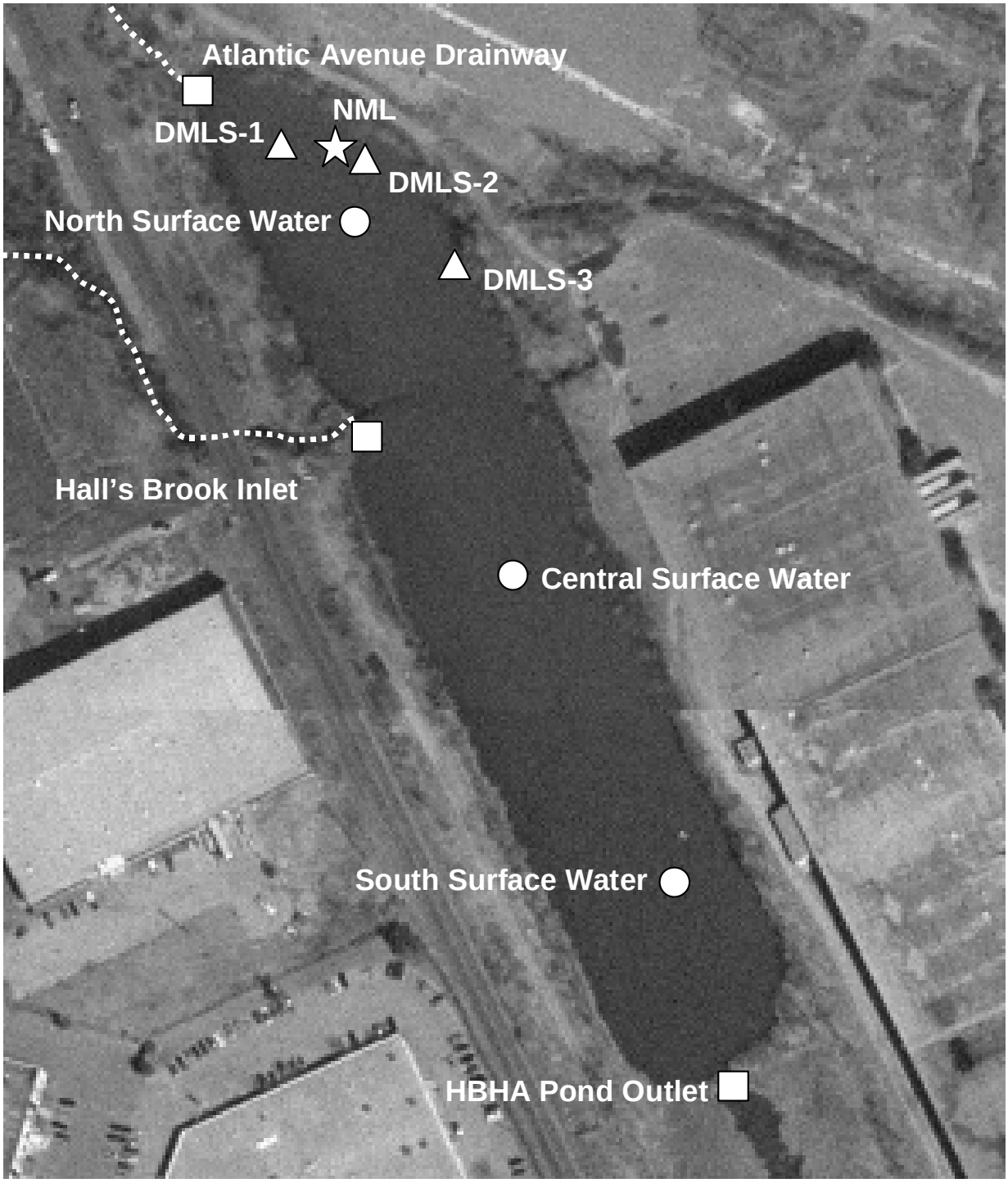
EPA/ORD SNAP-SHOT GROUNDWATER SAMPLE LOCATIONS	FIGURE 2-2
TECHNICAL MEMORANDUM - SUPPLEMENTAL DATA	TETRA TECH NUS, INC.
INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS	55 Jonspin Road Wilmington, MA 01887 (978)658-7899

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	G. BULLARD	DATE:	AUGUST 19, 2005
SCALE:	NOT NOTED	ACAD NAME:	\4123\1340\FIG_2-2.DWG



SOURCE: JUNE 24, 2005 MEMORANDUM FROM ROBERT FORD, EPA/ORD

EPA/ORD FIXED GROUNDWATER SAMPLE LOCATIONS			FIGURE 2-3
TECHNICAL MEMORANDUM – SUPPLEMENTAL DATA			TETRA TECH NUS, INC.
INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS			55 Jonspin Road Wilmington, MA 01887 (978)658-7899
DRAWN BY:	D.W. MACDOUGALL	REV.: 0	
CHECKED BY:	G. BULLARD	DATE: AUGUST 19, 2005	
SCALE:	NOT NOTED	ACAD NAME: \4123\1340\FIG_2-3.DWG	



SOURCE: JUNE 24, 2005 MEMORANDUM FROM ROBERT FORD, EPA/ORD

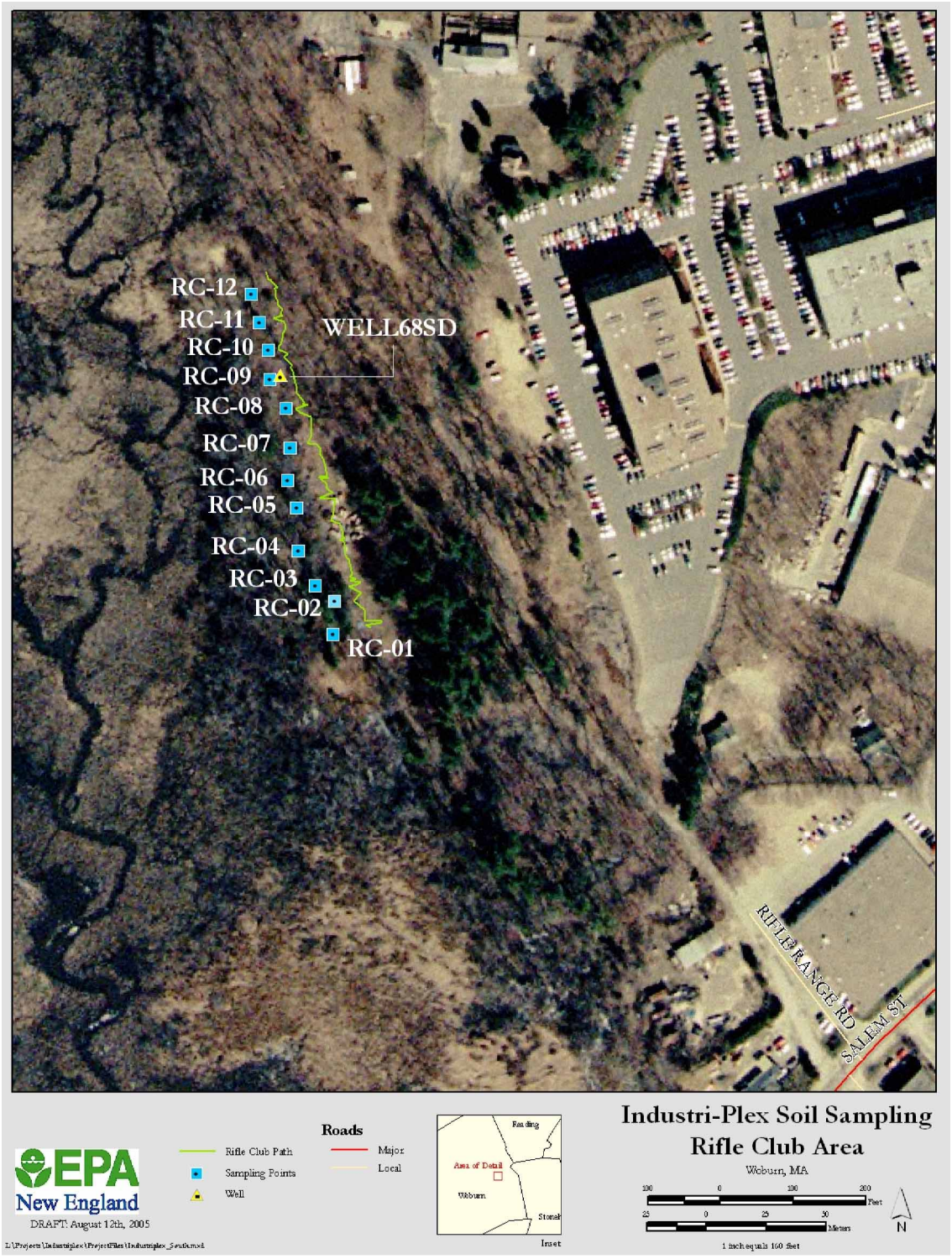
EPA/ORD SURFACE WATER SAMPLE LOCATIONS			FIGURE 2-4
TECHNICAL MEMORANDUM - SUPPLEMENTAL DATA			TETRA TECH NUS, INC.
INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS			55 Jonspin Road Wilmington, MA 01887 (978)658-7899
DRAWN BY:	D.W. MACDOUGALL	REV.: 0	
CHECKED BY:	G. BULLARD	DATE: AUGUST 19, 2005	
SCALE:	NOT NOTED	ACAD NAME: \4123\1340\FIG_2-4.DWG	

SOURCE: AUGUST 16, 2005 MEMORANDUM FROM JASON TURGEON, EPA/OES

INDUSTRI-PLEX WATER SAMPLING HALLS POND WATERSHED	FIGURE 2-5
TECHNICAL MEMORANDUM - SUPPLEMENTAL DATA	
INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS	

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	G. BULLARD	DATE:	AUGUST 19, 2005
SCALE:	AS NOTED	ACAD NAME:	\4123\1340\FIG_2-5.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899

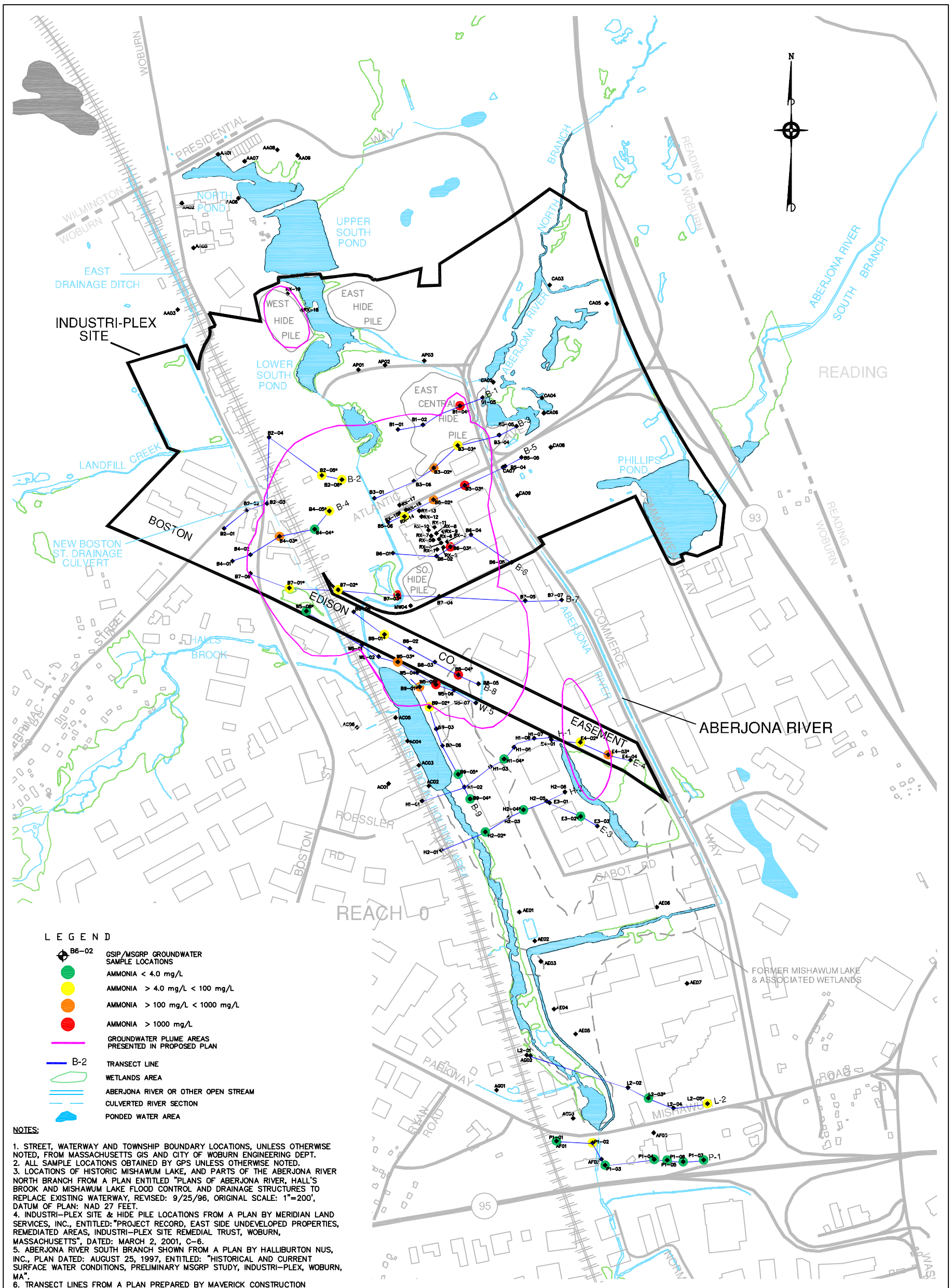


SOURCE: AUGUST 16, 2005 MEMORANDUM FROM JASON TURGEON, EPA/OES

INDUSTRI-PLEX SOIL SAMPLING RIFLE CLUB AREA	FIGURE 2-6
TECHNICAL MEMORANDUM - SUPPLEMENTAL DATA	
INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS	

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	G. BULLARD	DATE:	AUGUST 19, 2005
SCALE:	AS NOTED	ACAD NAME:	\4123\1340\FIG_2-6.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899



LEGEND

- B6–02 — GSIP/MSGRP GROUNDWATER SAMPLE LOCATIONS
- AMMONIA < 4.0 mg/L
- AMMONIA > 4.0 mg/L < 100 mg/L
- AMMONIA > 100 mg/L < 1000 mg/L
- AMMONIA > 1000 mg/L
- GROUNDWATER PLUME AREAS PRESENTED IN PROPOSED PLAN
- B-2 — TRANSECT LINE
- WETLANDS AREA
- ABERJONA RIVER OR OTHER OPEN STREAM
- CULVERTED RIVER SECTION
- PONDED WATER AREA

NOTES:

1. STREET, WATERWAY AND TOWNSHIP BOUNDARY LOCATIONS, UNLESS OTHERWISE NOTED, FROM MASSACHUSETTS GIS AND CITY OF WOBURN ENGINEERING DEPT.
2. ALL SAMPLE LOCATIONS OBTAINED BY GPS UNLESS OTHERWISE NOTED.
3. LOCATIONS OF HISTORIC MISHAWUM LAKE, AND PARTS OF THE ABERJONA RIVER NORTH BRANCH FROM A PLAN ENTITLED "PLANS OF ABERJONA RIVER, HALL'S BROOK AND MISHAWUM LAKE FLOOD CONTROL AND DRAINAGE STRUCTURES TO REPLACE EXISTING WATERWAY, REVISED: 9/25/96, ORIGINAL SCALE: 1"=200', DATUM OF PLAN: NAD 27 FEET.
4. INDUSTRI–PLEX SITE & HIDE PILE LOCATIONS FROM A PLAN BY MERIDIAN LAND SERVICES, INC., ENTITLED:"PROJECT RECORD, EAST SIDE UNDEVELOPED PROPERTIES, REMEDIATED AREAS, INDUSTRI–PLEX SITE REMEDIAL TRUST, WOBURN, MASSACHUSETTS", DATED: MARCH 2, 2001, C–6.
5. ABERJONA RIVER SOUTH BRANCH SHOWN FROM A PLAN BY HALLIBURTON NUS, INC., PLAN DATED: AUGUST 25, 1997, ENTITLED: "HISTORICAL AND CURRENT SURFACE WATER CONDITIONS, PRELIMINARY MSGRP STUDY, INDUSTRI–PLEX, WOBURN, MA".
6. TRANSECT LINES FROM A PLAN PREPARED BY MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC. & MERIDIAN LAND SERVICES, INC., AMHERST, NH, ENTITLED: "PLANIMETRIC WORKSHEET, INDUSTRI–PLEX SITE REMEDIAL TRUST, SITE BASEMAP, INDUSTRI–PLEX SITE REMEDIAL TRUST, WOBURN, MASSACHUSETTS", SCALE: 1"= 300', DATED: SEPTEMBER 29, 2000.
7. PLAN COORDINATES IN NAD 83 FEET; ALL LOCATIONS (IF NECESSARY) CONVERTED FROM ORIGINAL DATUM TO NAD 83 FEET USING BLUE MARBLE GEOGRAPHIC CALCULATOR SOFTWARE (VERSION 4.2).
8. PLAN NOT TO BE USED FOR DESIGN.
9. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
10. THE WATERWAY BOUNDARIES SHOWN MAY NOT REPRESENT THE LIMITS OF THE WATERWAYS AT THE TIME OF SAMPLING DUE TO SEASONAL VARIATIONS IN WATERWAY BOUNDARIES AND POTENTIAL ERRORS IN WATERWAY MAPPING.
11. REFER TO EPA OFFICE OF RESEARCH & DEVELOPMENT, JUNE 24, 2005, MEMORANDUM FOR ADDITIONAL AMMONIA GROUNDWATER DATA.

GRAPHIC SCALE

0′ 800′ 1600′

AMMONIA CONCENTRATIONS IN GROUNDWATER

TECHNICAL MEMORANDUM – SUPPLEMENTAL DATA

INDUSTRI–PLEX SITE, WOBURN, MASSACHUSETTS

FIGURE 3–1

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	G. BULLARD	DATE:	OCTOBER 17, 2005
SCALE:	AS SHOWN	FILE NO.:	\4123\1340\FIG_3–1.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658–7899

RR-4 APPROXIMATELY 2000 FT NORTH OF THIS LOCATION AT EAMES STREET

INDUSTRI-PLEX SITE

N

NORTH POND

UPPER SOUTH POND

LOWER SOUTH POND

EAST DRAINAGE DITCH

WEST HIDE PILE

EAST HIDE PILE

EAST CENTRAL HIDE PILE

ABERJONA RIVER SOUTH BRANCH

PHILLIPS POND

LANDFILL CREEK

ATLANTIC

RAILROAD

ARSENIC
BENZENE
AMMONIA

HBHA POND

TT #2

TT #3

TT #4

TT #5

HBHA POND

SW OUTLET

SHALLOW SW
LOW ARSENIC
LOW BENZENE
LOW AMMONIA

CHEMOCLINE

DEEP SW
HIGH ARSENIC
HIGH BENZENE
HIGH AMMONIA

GW
ARSENIC
BENZENE
AMMONIA

SEDIMENTS

HALLS BROOK HOLDING AREA
CONCENTRATED SOURCE OF ARSENIC IN SURFACE WATER AND SEDIMENT DEPOSITION

WOBURN

FORMER MISHAWUM LAKE & WETLANDS

HBHA WETLANDS

WELLS G & H SITE

MERRIMAC STREET

BOSTON ROESSLER RD

NEW INDUSTRIAL PARKWAY

RYAN ROAD

MISHAWUM ROAD

ALFRED STREET

95

OLYMPIA AVENUE

WASHINGTON

COMMERCIAL WAY

ABBOTT RD

WILDWOOD AVENUE

CEDAR

WELL "H"

WELL "G"

WELL "H"

WELL "G"

WELLS G & H WETLAND AREA
SIGNIFICANT AREA OF ARSENIC DEPOSITION

LEGEND

- WETLANDS AREA
- ABERJONA RIVER OR OTHER OPEN STREAM
- CULVERTED RIVER SECTION
- PONDED WATER AREA
- GROUNDWATER PLUME
- EPA AMMONIA SURFACE WATER SAMPLING LOCATION (JULY 2005)
- EPA METALS SOIL SAMPLING LOCATION (JULY 2005)

NOTES:

1. LOCATIONS OF TOWN BOUNDARIES, MAJOR ROADS, STREETS WATER BODIES AND WATER COURSES FROM PLANS BY THE MASSACHUSETTS GIS AND CITY OF WOBURN ENGINEERING DEPT. (2003) EXCEPT AS NOTED BELOW.
2. LOCATIONS OF HISTORIC MISHAWUM LAKE, AND HISTORIC ABERJONA RIVER NORTH BRANCH FROM A PLAN ENTITLED 'PLANS OF ABERJONA RIVER, HALL'S BROOK AND MISHAWUM LAKE FLOOD CONTROL AND DRAINAGE STRUCTURES TO REPLACE EXISTING WATERWAY, WOBURN, MA, FOR PETITION OF MARK PHILLIP TRUST', WESTON & SAMPSON ENGINEERS, DATED: NOV. 1974.
3. PARTS OF THE ABERJONA RIVER SOUTH BRANCH SHOWN FROM A PLAN BY HALLIBURTON NUS, INC., PLAN DATED: AUGUST 25, 1997, ENTITLED: 'HISTORICAL AND CURRENT SURFACE WATER CONDITIONS, PRELIMINARY MSGRP STUDY, INDUSTRI-PLEX, WOBURN, MA'.
4. SURFACE WATER FEATURES ADAPTED FROM FIGURE 39 (ABERJONA RIVER STUDY AREA, WETLANDS STATUS & RIVER COURSES, 1995) FROM A REPORT ENTITLED: AERIAL PHOTOGRAPHIC ANALYSIS OF THE ABERJONA RIVER STUDY AREA MIDDLESEX COUNTY, MASSACHUSETTS', OCTOBER, 2002, BY U.S. E.P.A. AND ONE METER AERIAL PHOTOGRAPHS OBTAINED FROM THE MASSACHUSETTS GIS.
5. ROADS AND WATER COURSES UNAVAILABLE FROM ABOVE SOURCES ADDED FROM AVAILABLE PLANS AND/OR FIELD OBSERVATIONS.
6. PLAN DATUM IN NAD 83 FEET; ORIGINAL DATUM FROM OTHER PLANS CONVERTED TO NAD 83 FEET USING THE GEOGRAPHIC CALCULATOR BY BLUE MARBLE GEOGRAPHICS, VERSION 4.2.
7. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
8. PLAN NOT TO BE USED FOR DESIGN.
9. SEE EPA'S MARCH 2005 MSGRP REMEDIAL INVESTIGATION REPORT FOR FURTHER KEY CONTAMINANT MIGRATION PATHWAYS.
10. SEE APPENDIX B - JULY 2005 SURFACE WATER AND SOIL SAMPLE RESULTS FOR SPECIFIC SAMPLE IDENTIFICATION NUMBERS AND LOCATIONS.

GRAPHIC SCALE
0' 1200' 2400'

PARTIAL KEY CONTAMINANT MIGRATION PATHWAYS WITH AMMONIA AND JULY 2005 SAMPLE LOCATIONS

TECHNICAL MEMORANDUM – SUPPLEMENTAL DATA

INDUSTRI-PLEX SITE, WOBURN, MASSACHUSETTS

FIGURE 3-2

DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	G. BULLARD	DATE:	OCTOBER 17, 2005
SCALE:	AS NOTED	FILE NO.:	DWG\4123\1340\FIG_3-2.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899

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REFERENCES

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APPENDIX A

NATURAL ATTENUATION STUDY AMMONIA DATA IN SURFACE WATER

June 24, 2005

MEMORANDUM

SUBJECT: Industri-Plex Superfund Site and GSIP Study Area; Ammonia Data for Water Quality Samples

FROM: Robert Ford, EPA/ORD

TO: Joseph LeMay, RPM EPA/Region 1

Attached are tables that document measurements of temperature, pH, and dissolved ammonia-nitrogen in water samples collected from ground water, surface water, and sediment pore water within the Industri-Plex Site boundary and GSIP Study Area during the period October 1999 – September 2004 (Tables 1-16). The positions of sampling locations are shown in Figures 1-3. Analytical measurements were made according to procedures specified in the Natural Attenuation Study Work Plan (Revision 2; September 14, 2000).

Table 1. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during snap-shot ground water sampling on October 13-21, 1999 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft	Depth to Bedrock ft bgs	Temp. °C	pH	NH_3-N mg N/L
A01-1	10/14/99	32.75	NM	NM	NM	6.62	63.7
A01-2	10/15/99	41.75	NM	NM	NM	NM	22.4
A02-1	10/14/99	12.00	2.25	14.08	NM	6.70	79.3
A03-1	10/15/99	9.00	1.00	22.00	NM	6.61	1.9
A03-2	10/15/99	19.00	11.00	22.00	NM	6.66	1.6
A04-1	10/15/99	15.00	5.29	32.50	NM	6.92	18.8
A04-2	10/15/99	24.75	15.04	32.50	NM	NM	6.0
A04-3	10/15/99	32.50	22.79	32.50	NM	NM	1.5
A05-1	10/15/99	8.50	NM	8.50	NM	6.72	3.4
A06-1	10/18/99	15.50	NM	27.50	NM	7.27	8.6
A06-2	10/18/99	25.50	NM	27.50	NM	6.26	3.5
A07-1	10/18/99	13.50	NM	NM	NM	6.03	0.8
A07-2	10/18/99	23.50	NM	NM	NM	6.39	0.2
A08-1	10/19/99	9.00	3.42	64.00	7.50	6.72	0.9
A08-2	10/19/99	19.00	13.42	64.00	8.10	6.57	1.3
A08-3	10/19/99	39.00	33.42	64.00	NM	7.07	96.4
A09-1	10/19/99	12.50	2.83	47.08	NM	6.14	0.8
A09-2	10/19/99	22.50	12.83	47.08	11.40	NM	10.7
A09-3	10/19/99	43.00	33.33	47.08	NM	NM	NM
A10-1	10/20/99	10.00	NM	NM	NM	6.46	NM
A10-2	10/20/99	20.00	NM	NM	11.10	7.14	235.7
A10-3	10/20/99	30.00	NM	NM	11.60	7.51	810.1
A11-1	10/20/99	10.50	1.67	NM	NM	6.68	8.8
A11-2	10/20/99	20.50	11.67	NM	NM	7.80	709.3
A11-3	10/20/99	30.50	21.67	NM	NM	7.79	77.7
A12-1	10/20/99	12.00	4.70	NM	12.80	6.19	16.3
A12-2	10/21/99	22.00	14.70	NM	11.90	6.37	14.6
A12-3	10/21/99	32.00	24.70	NM	12.60	6.58	18.6
A13-1	10/20/99	7.50	1.08	45.00	NM	6.88	1142.6
A13-2	10/20/99	17.50	11.08	45.00	NM	8.04	1141.8
A13-3	10/20/99	34.50	28.08	45.00	NM	NM	NM
A13-4	10/20/99	45.00	38.58	45.00	NM	NM	244.2

Table 2. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during snap-shot ground water sampling on November 30 – December 3, 1999 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NA = not applicable, ND = not detected, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft	Depth to Bedrock ft bgs	Temp. °C	pH	NH_3-N mg N/L
A14-1	11/30/99	10.00	0.71	NM	5.2	5.56	3.4
A14-2	11/30/99	15.00	5.71	NM	6.4	6.40	NM
A14-3	11/30/99	30.00	20.71	NM	NM	NM	NM
A15-1[1]	11/30/99	11.80	NA	11.80	NM	NM	ND
A16-1	12/01/99	7.00	1.67	NM	6.3	6.13	NM
A16-2	12/01/99	12.00	6.67	NM	NM	NM	NM
A17-1	12/01/99	7.00	3.00	NM	9.6	7.11	NM
A17-3	12/01/99	17.00	13.00	NM	NM	NM	NM
A18-1	12/02/99	19.00	10.19	NM	13.0	6.27	1.2
A19-1	12/02/99	8.50	1.50	NM	10.7	6.01	ND

1 Ground water yield too low to connect to flow cell.

Table 3. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during snap-shot and fixed point ground water sampling on March 27 – April 6, 2000 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NA = not applicable, NS = not sampled, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft	Depth to Bedrock ft bgs	Temp. °C	pH	NH_3-N mg N/L
A20-1	3/28/00	5.00	2.38	NM	11.9	6.47	2.0
A20-2	3/28/00	10.00	7.38	NM	12.4	6.21	0.9
A21-1	3/30/00	5.50	2.00	NM	13.4	6.62	0.8
A21-2	3/30/00	13.50	10.00	NM	10.2	6.88	77.7
A22-1	3/31/00	9.75	3.50	NM	13.5	5.53	9.8
A22-2	3/31/00	14.75	8.50	NM	11.8	6.24	31.7
A23-1	3/31/00	9.75	2.75	NM	13.7	4.64	2.2
A23-2 [1]	4/3/00	16.75	9.75	NM	NM	NM	2.2
TW01	3/29/00	9.00 [2]	NA	NM	11.1	NM	874.0
TW02	4/6/00	14.00 [2]	NA	NM	8.1	7.56	1260.0
TW03	3/29/00	13.00 [2]	NA	NM	13.8	6.06	37.9
TW04	3/29/00	14.00 [2]	NA	NM	10.9	5.94	2.5
TW05	NS	11.00 [2]	NA	NM	NM	NM	NM
TW06-1	4/5/00	12.25	NM	47.08	13.1	6.44	0.5
TW06-2	4/5/00	17.50	NM	47.08	10.9	5.99	NM
TW06-3	4/5/00	22.50	NM	47.08	9.8	5.04	7.4
TW07-1	4/4/00	12.25	NM	NM	13.1	6.16	5.6
TW07-2	4/5/00	15.00	NM	NM	12.0	5.90	4.1
TW07-3	4/5/00	20.00	NM	NM	11.8	6.03	14.9
TW08-1	4/6/00	8.00	NM	NM	6.7	8.02	722.0
TW08-2	4/6/00	13.00	NM	NM	6.1	5.42	ND
TW08-3	4/6/00	17.50	NM	NM	8.1	6.70	229.0

1 Ground water yield too low to connect to flow cell.
2 Screen depth is below water surface of Hall's Brook Holding Area Pond determined at the time of installation.

Table 4. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during fixed point ground water sampling on May 16-18, 2000 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NA = not applicable, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft	Depth to Bedrock ft bgs	Temp. °C	pH	NH_3-N mg N/L
TW01	5/17/00	9.00 [1]	NA	NM	14.1	7.26	1065.0
TW02	5/16/00	14.00 [1]	NA	NM	16.8	7.72	1191.0
TW03	5/16/00	13.00 [1]	NA	NM	16.6	5.95	41.3
TW04	5/16/00	14.00 [1]	NA	NM	15.4	6.19	2.5
TW05	5/17/00	11.00 [1]	NA	NM	14.1	5.22	8.0
TW06-1	5/16/00	12.25	NM	47.08	14.6	6.32	NM
TW06-2	5/16/00	17.50	NM	47.08	14.1	5.83	1.2
TW06-3	5/16/00	22.50	NM	47.08	13.7	5.25	8.4
TW07-1	5/16/00	12.25	NM	NM	16.0	5.72	4.9
TW07-2	5/16/00	15.00	NM	NM	13.8	5.82	5.5
TW07-3	5/16/00	20.00	NM	NM	15.3	5.86	16.5
TW08-1	5/17/00	8.00	NM	NM	15.5	7.82	851.0
TW08-2	5/17/00	13.00	NM	NM	14.3	5.33	2.4
TW08-3	5/17/00	17.50	NM	NM	15.9	6.63	220.0
TW10-1	5/16/00	10.58	NM	NM	14.8	6.65	2.3
TW10-2	5/16/00	15.58	NM	NM	15.4	6.12	26.8
TW10-3	5/16/00	20.58	NM	NM	16.2	6.24	35.2

1 Screen depth is below water surface of Hall's Brook Holding Area Pond determined at the time of installation.

Table 5. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during fixed point ground water sampling on August 22-30, 2000 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NA = not applicable, ND = not detected, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft	Depth to Bedrock ft bgs	Temp. (°C)	pH	NH_3-N mg N/L
TW01	8/23/00	9.00 [1]	NA	NM	20.7	7.26	897.0
TW02	8/23/00	14.00 [1]	NA	NM	17.9	7.44	1170.0
TW03	8/22/00	13.00 [1]	NA	NM	21.4	5.97	37.9
TW04	8/23/00	14.00 [1]	NA	NM	18.7	6.13	2.3
TW05	8/23/00	11.00 [1]	NA	NM	18.9	5.12	8.2
TW06-1	8/22/00	12.25	NM	47.08	21.9	6.15	1.0
TW06-2	8/22/00	17.50	NM	47.08	20.5	5.83	1.3
TW06-3	8/22/00	22.50	NM	47.08	18.6	5.21	9.0
TW07-1	8/23/00	12.25	NM	NM	15.7	5.90	5.3
TW07-2	8/23/00	15.00	NM	NM	17.1	6.07	5.7
TW07-3	8/23/00	20.00	NM	NM	15.6	6.04	19.3
TW08-1	8/23/00	8.00	NM	NM	20.6	7.80	916.0
TW08-2	8/23/00	13.00	NM	NM	21.2	5.14	ND
TW08-3	8/23/00	17.50	NM	NM	22.1	6.78	276.0
TW10-1	8/22/00	10.58	NM	NM	22.0	6.45	2.0
TW10-2	8/22/00	15.58	NM	NM	20.8	6.04	24.8
TW10-3	8/22/00	20.58	NM	NM	19.0	6.26	34.8
TW11	8/30/00	3.50	1.50	NM	17.7	6.14	1.5
TW12-1	8/30/00	3.50	1.50	NM	20.1	6.28	0.1
TW12-2	8/30/00	8.50	1.50	NM	20.1	6.25	0.2
TW13	8/30/00	3.50	1.50	NM	22.4	6.28	1.5

1 Screen depth is below water surface of Hall's Brook Holding Area Pond determined at the time of installation.

Table 6. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during fixed point ground water sampling on March 28 – April 3, 2001 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NA = not applicable, NS = not sampled, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft)	Depth to Bedrock ft bgs	Temp. (°C)	pH	NH_3-N mg N/L
TW01	4/3/2001	9.00 [1]	NA	NM	7.4	7.02	1090.0
TW02	3/29/01	14.00 [1]	NA	NM	8.6	7.67	1110.0
TW03	NS	13.00 [1]	NA	NM	NM	NM	NM
TW04	3/29/01	14.00 [1]	NA	NM	7.5	6.73	1.9
TW05	NS	11.00 [1]	NA	NM	NM	NM	NM
TW06-1	NS	12.25	NM	47.08	NM	NM	NM
TW06-2	NS	17.50	NM	47.08	NM	NM	NM
TW06-3	NS	22.50	NM	47.08	NM	NM	NM
TW07-1	3/29/01	12.25	NM	NM	8.5	5.99	5.2
TW07-2	3/29/01	15.00	NM	NM	7.6	6.23	7.2
TW07-3	3/29/01	20.00	NM	NM	9.7	6.14	18.2
TW08-1	4/3/01	8.00	NM	NM	8.3	8.02	405.0
TW08-2	NS	13.00	NM	NM	NM	NM	NM
TW08-3	4/3/01	17.50	NM	NM	9.8	6.73	303.0
TW10-1	4/2/01	10.58	NM	NM	4.2	6.72	0.9
TW10-2	4/2/01	15.58	NM	NM	4.9	6.38	18.0
TW10-3	4/2/01	20.58	NM	NM	6.6	6.46	31.4
TW11	NS	3.50	1.50	NM	NM	NM	NM
TW12-1	NS	3.50	1.50	NM	NM	NM	NM
TW12-2	NS	8.50	1.50	NM	NM	NM	NM
TW13	NS	3.50	1.50	NM	NM	NM	NM

1 Screen depth is below water surface of Hall's Brook Holding Area Pond determined at the time of installation.

Table 7. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during fixed point ground water sampling on September 13 – 17, 2001 at the Industri-Plex Site and GSIP Study Area. The following abbreviations are used within the table: ft bgs = feet below ground surface, NA = not applicable, ND = not detected, NS = not sampled, NM = not measured.

Location	Date	Screen Depth ft bgs	Depth to Water Table ft	Depth to Bedrock ft bgs	Temp. °C	pH	NH_3-N mg N/L
TW01	9/11/01	9.00 [1]	NA	NM	23.7	7.37	1380.0
TW02	9/11/01	14.00 [1]	NA	NM	21.8	7.39	1180.0
TW03	NS	13.00 [1]	NA	NM	NM	NM	NM
TW04	9/11/01	14.00 [1]	NA	NM	22.8	6.13	11.7
TW05	9/13/01	11.00 [1]	NA	NM	19.7	5.64	8.5
TW06-1	NS	12.25	NM	47.08	NM	NM	NM
TW06-2	NS	17.50	NM	47.08	NM	NM	NM
TW06-3	NS	22.50	NM	47.08	NM	NM	NM
TW07-1	9/11/01	12.25	NM	NM	17.6	5.65	7.4
TW07-2	9/11/01	15.00	NM	NM	18.8	5.90	27.5
TW07-3	9/11/01	20.00	NM	NM	17.8	5.73	8.7
TW08-1	9/10/01	8.00	NM	NM	21.3	7.66	797.0
TW08-2	9/10/01	13.00	NM	NM	21.2	5.11	ND
TW08-3	9/10/01	17.50	NM	NM	21.3	6.78	365.0
TW10-1	9/12/01	10.58	NM	NM	21.5	6.67	0.4
TW10-2	9/12/01	15.58	NM	NM	21.2	6.25	27.4
TW10-3	9/12/01	20.58	NM	NM	22.2	6.25	33.8
TW11	NS	3.50	1.50	NM	NM	NM	NM
TW12-1	NS	3.50	1.50	NM	NM	NM	NM
TW12-2	NS	8.50	1.50	NM	NM	NM	NM
TW13	NS	3.50	1.50	NM	NM	NM	NM

1 Screen depth is below water surface of Hall's Brook Holding Area Pond determined at the time of installation.

Table 8. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during surface water sampling on November 30 – December 3, 1999 in the Hall's Brook Holding Area Pond. Data were collected using a YSI submersible multi-electrode sonde. The following abbreviations are used within the table: NM = not measured.

Location	Date	Sonde Depth cm	Temp. °C	pH	NH_3-N mg N/L
WN50	11/30/99	50	7.07	6.32	9.50
WN100	11/30/99	100	7.14	6.32	9.87
WN150	11/30/99	150	7.29	6.22	17.00
WN200	11/30/99	200	9.44	6.08	42.50
WN250	11/30/99	250	11.53	6.49	NM
WN260	11/30/99	260	NM	NM	NM
WC50	11/30/99	50	7.07	6.34	9.36
WC100	11/30/99	100	7.08	6.31	9.34
WC150	11/30/99	150	7.11	6.32	9.86
WC200	11/30/99	200	8.05	6.12	33.60
WC250	11/30/99	250	9.7	6.49	NM
WS50	11/30/99	50	6.99	6.29	9.58
WS100	11/30/99	100	6.99	6.3	9.54
WS150	11/30/99	150	7.01	6.29	9.57
WS200	11/30/99	200	9.3	6.21	NM
WS250	11/30/99	250	9.54	6.45	NM
WS300	11/30/99	320	10.16	6.84	NM

Table 9. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during surface water sampling on March 27 – April 6, 2000 in the Hall's Brook Holding Area Pond. Data were collected using a YSI submersible multi-electrode sonde. The following abbreviations are used within the table: NM = not measured.

Location	Date	Sonde Depth cm	Temp. °C	pH	NH_3-N mg N/L
WN50	4/4/00	50	10.83	6.79	7.4
WN100	4/4/00	100	10.82	6.95	7.4
WN150	4/4/00	150	10.87	7.02	7.5
WN175	4/4/00	175	10.87	7.04	8.2
WN200	4/4/00	200	10.89	7.05	8.0
WN225	4/4/00	225	10.91	6.96	8.4
WN250	4/4/00	250	10.83	7.19	99.1
WN300	4/4/00	300	10.44	7.51	597.0
WC50	4/4/00	50	11.39	7.03	7.6
WC100	4/4/00	100	11.46	6.98	7.3
WC150	4/4/00	150	11.52	6.97	7.3
WC200	4/4/00	200	11.05	6.81	24.1
WC250	4/4/00	250	9.95	6.5	8.0
WC275	4/4/00	275	9.95	6.58	27.3
WC300	4/4/00	300	9.60	7.35	NM
WS50	4/4/00	50	11.61	6.99	7.9
WS100	4/4/00	100	10.92	6.87	8.3
WS150	4/4/00	150	10.78	6.78	8.8
WS200	4/4/00	200	10.40	6.7	9.1
WS250	4/4/00	250	9.31	6.39	12.7
WS300	4/4/00	300	8.98	7.12	80.5
WS340	4/4/00	340	8.94	7.33	NM

Table 10. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during surface water sampling on August 22-30, 2000 in the Hall's Brook Holding Area Pond. Data were collected using a YSI submersible multi-electrode sonde. The following abbreviations are used within the table: NS = not sampled, NM = not measured.

Location	Date	Sonde Depth (cm)	Temp. (°C)	pH	NH_3-N mg N/L
WN50	8/25/00	50	19.00	7.12	13.1
WN100	8/25/00	100	18.54	7.28	14.7
WN150	8/25/00	150	17.76	7.16	15.5
WN180	8/25/00	180	15.29	7.37	68.8
WN200	8/25/00	200	14.28	7.20	132.0
WC50	8/25/00	50	22.26	7.52	14.8
WC100	8/25/00	100	19.23	7.39	15.2
WC150	8/25/00	150	17.74	7.35	44.0
WC200	8/25/00	200	15.23	7.76	61.0
WC250	8/25/00	240	15.23	8.02	119.0
WS50	8/29/00	50	20.47	6.75	16.0
WS100	8/29/00	100	19.30	6.58	31.1
WS150	8/29/00	150	18.57	6.61	60.3
WS200	8/29/00	200	15.99	7.21	103.0
WS240	8/29/00	240	15.08	7.31	119.0

Table 11. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during surface water sampling on March 28 – April 3, 2001 in the Hall's Brook Holding Area Pond. Data were collected using a YSI submersible multi-electrode sonde.

Location	Date	Sonde Depth (cm)	Temp. (°C)	pH	NH_3-N mg N/L
WN50	4/2/01	50	4.1	6.34	5.4
WN100	4/2/01	100	4.1	6.13	5.5
WN150	4/2/01	150	4.1	6.16	6.0
WN200	4/2/01	200	4.1	6.16	6.4
WN250	4/2/01	250	4.4	6.71	7.0
WN270	4/2/01	270	4.6	6.46	6.8
WN310	4/2/01	310	6.4	6.50	95.5
WC50	4/2/01	50	4.0	5.10	5.0
WC100	4/2/01	100	4.5	5.23	5.3
WC150	4/2/01	150	4.8	5.03	4.8
WC200	4/2/01	200	4.9	5.82	5.1
WC250	4/2/01	250	4.8	6.29	5.1
WC300	4/2/01	300	4.9	6.53	5.2
WS50	4/2/01	50	5.1	6.20	5.3
WS100	4/2/01	100	5.3	6.17	5.1
WS150	4/2/01	150	5.2	6.43	5.1
WS200	4/2/01	200	5.4	6.63	5.1
WS250	4/2/01	250	5.2	6.72	5.1
WS300	4/2/01	300	5.2	6.78	5.1

Table 12. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during surface water sampling on September 13 – 17, 2001 in the Hall's Brook Holding Area Pond. Data were collected using a YSI submersible multi-electrode sonde. The following abbreviations are used within the table: NM = not measured.

Location	Date	Sonde Depth (cm)	Temp. (°C)	pH	NH_3-N mg N/L
WC50	9/17/01	50	16.4	6.58	16.4
WC100	9/17/01	100	16.3	6.56	17.9
WC150	9/17/01	150	16.5	6.33	44.8
WC200	9/17/01	200	16.5	6.42	79.6
WC250	9/17/01	250	16.0	6.60	115.0
WC300	9/17/01	300	15.7	6.57	151.0
WC320	9/17/01	320	15.6	6.72	NM
WS50	9/17/01	50	17.0	6.66	15.1
WS100	9/17/01	100	16.8	6.69	24.0
WS150	9/17/01	150	16.4	6.37	38.0
WS200	9/17/01	200	16.8	6.50	90.6
WS250	9/17/01	250	16.0	6.65	112.0
WS300	9/17/01	300	15.2	6.79	117.0
WS330	9/17/01	330	14.7	7.17	NM

Table 13. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during surface water sampling on September 21, 2004 in the Hall's Brook Holding Area Pond. Data were collected using a YSI submersible multi-electrode sonde. The following abbreviations are used within the table: NM = not measured.

Location	Date	Sonde Depth (cm)	Temp. (°C)	pH	NH_3-N mg N/L
WS50	9/20/04	50	16.72	6.42	2.0
WS100	9/20/04	100	15.90	6.28	2.2
WS150	9/20/04	150	14.19	6.18	2.4
WS200	9/20/04	200	14.15	6.23	2.4
WS300	9/20/04	300	14.12	6.33	2.3
WS350	9/20/04	350	14.09	6.26	4.4
WS400	9/20/04	400	14.90	6.87	104.0

Table 14. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements for inlets and outlet of the Hall's Brook Holding Area Pond. The following abbreviations are used within the table: NM = not measured.

Location	Date	Temp. (°C)	pH	NH_3-N mg N/L
Hall's Brook Inlet	4/5/00	11.5	7.93	5.2
	5/18/00	14.0	7.44	7.8
	8/30/00	19.4	7.22	7.6
	4/5/01	11.0	6.86	5.5
	9/16/01	15.1	6.97	4.1
	9/20/04	NM	NM	3.3
Atlantic Ave. Drainway	4/5/00	11.1	7.14	0.1
	5/18/00	NM	NM	NM
	8/24/00, A [1]	16.7	6.33	NM
	8/24/00, B [1]	18.2	5.94	NM
	4/5/01	NM	NM	2.2
	9/20/04	NM	NM	0.7
HBHA Pond Outlet	4/5/00	12.0	6.70	7.4
	5/18/00	16.0	7.14	8.0
	8/30/00	22.6	6.95	16.0
	4/5/01	10.9	6.76	6.9
	9/16/01	21.6	6.73	17.2
	9/20/04	NM	NM	4.0

1 Dates '8/24/00, A' and'8/24/00, B' refer to samples collected at two closely spaced locations at Atlantic Avenue Drainway outlet.

Table 15. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected during water sampling from North Multi-Level Station in the Hall's Brook Holding Area Pond. The following abbreviations are used within the table: NM = not measured.

Location	Date	Screen Depth (cm)	Temp. (°C)	pH	NH_3-N mg N/L
NML-1	4/5/01	69	NM	NM	NM
	4/10/01		11.8	6.18	NM
	5/14/01		14.1	6.63	12.2
	9/14/01		15.8	6.25	17.2
	9/21/04		NM	NM	NM
NML-2	4/5/01	119	9.5	6.53	8.2
	4/10/01		10.5	6.15	NM
	5/14/01		13.6	6.54	16.1
	5/31/01		15.6	6.44	NM
	9/14/01		16.1	6.31	14.9
	9/21/04		NM	NM	NM
NML-3	4/5/01	169	NM	NM	NM
	4/10/01		11.4	6.28	NM
	5/14/01		13.9	6.21	21.3
	9/14/01		16.4	5.23	18.3
	9/21/04		NM	NM	NM
NML-4	4/5/01	219	9.4	6.53	9.9
	4/10/01		10.9	6.54	NM
	5/14/01		14.2	6.24	42.6
	9/14/01		16.3	6.11	80.3
	9/21/04		NM	NM	NM
NML-5	4/5/01	269	9.9	6.42	63.2
	4/10/01		10.6	6.71	NM
	5/14/01		14.1	6.54	323.0
	9/13/01		22.9	6.68	449.0
	9/21/04		NM	NM	NM
NML-6	4/5/01	319	9.6	6.64	297.0
	4/10/01		10.6	6.56	NM
	5/14/01		14.8	6.81	817.0
	5/31/01		15.2	7.03	NM
	9/13/01		23.9	6.84	1050.0
	9/21/04		16.0	6.98	933.0
NML-7	4/5/01	369	9.9	7.14	1170.0
	4/10/01		11.3	6.62	NM
	5/14/01		14.8	6.73	1180.0
	9/13/01		24.8	6.73	1160.0
	9/21/04		16.8	6.93	1110
NML-8	4/5/01	419	10.4	6.86	1150.0
	4/10/01		10.7	6.68	NM
	5/14/01		16.4	6.74	1230.0
	9/13/01		27.5	6.79	1270.0
	9/21/04		17.9	6.83	1100.0
NML-9	4/5/01	469	NM	NM	1100.0
	4/10/01		NM	NM	NM
	5/14/01		NM	NM	1890.0
	9/14/01		NM	NM	2050.0
	9/21/04		NM	NM	NM
NML-10	4/5/01	519	10.1	7.49	1980.0
	4/10/01		12.7	7.28	NM
	5/14/01		15.9	7.09	2100.0
	9/13/01		21.3	7.46	2110.0
	9/21/04		18.6	7.14	1670.0

Table 16. Summary of temperature and pH data (field measurements) and laboratory ammonia measurements collected from Discrete Multi-level Samplers installed within the Hall's Brook Holding Area Pond. The following abbreviations are used within the table: ND = not detected, NM = not measured, SWI = sediment-water interface.

Location	Relative Depth cm	pH	NH_3-N mg N/L	Comments
DMLS-1 Installed: 4/3/00 Retrieved: 8/29/00	0.0	NM	ND	Above SWI
	11.4	NM	344.3	Above SWI
	22.9	NM	368.5	Above SWI
	34.3	NM	405.9	Above SWI
	45.7	NM	381.7	Above SWI
	57.2	NM	374.0	Above SWI
	74.6	NM	355.3	Below SWI
	86.0	NM	343.2	Below SWI
	97.5	NM	365.2	Below SWI
	108.9	NM	NM	Below SWI; sample cell not recovered
	120.3	NM	NM	Below SWI; sample cell not recovered
DMLS-2 Installed: 8/30/00 Retrieved: 4/3/01	0.0	6.85	238. 6	Above SWI
	11.4	6.90	387.2	Above SWI
	22.9	7.49	1762.2	Above SWI
	34.3	NM	1930.1	Below SWI
	45.7	7.31	2073.9	Below SWI
	57.2	7.46	2037.9	Below SWI
	74.6	7.38	2037.9	Below SWI
	86.0	NM	NM	Below SWI ; sample cell not recovered
	97.5	7.27	2014.0	Below SWI
	108.9	NM	2325.7	Below SWI
	120.3	7.61	2349.7	Below SWI
DMLS-3 Installed: 4/3/01 Retrieved: 9/12/01	0.0	6.96	738.1	Below SWI
	11.4	6.90	658.2	Below SWI
	22.9	6.93	719.8	Below SWI
	34.3	6.95	655.8	Below SWI
	45.7	7.07	637.1	Below SWI
	57.2	6.81	610.2	Below SWI
	74.6	6.84	600.2	Below SWI
	86.0	6.97	588.7	Below SWI
	97.5	6.86	584.8	Below SWI
	108.9	6.86	573.7	Below SWI
	120.3	6.88	479.5	Below SWI

Figure 1. Snap-shot ground water sampling locations for the Industri-Plex Site and GSIP Study Area. Image was derived from April 2001 aerial photograph obtained from MassGIS.

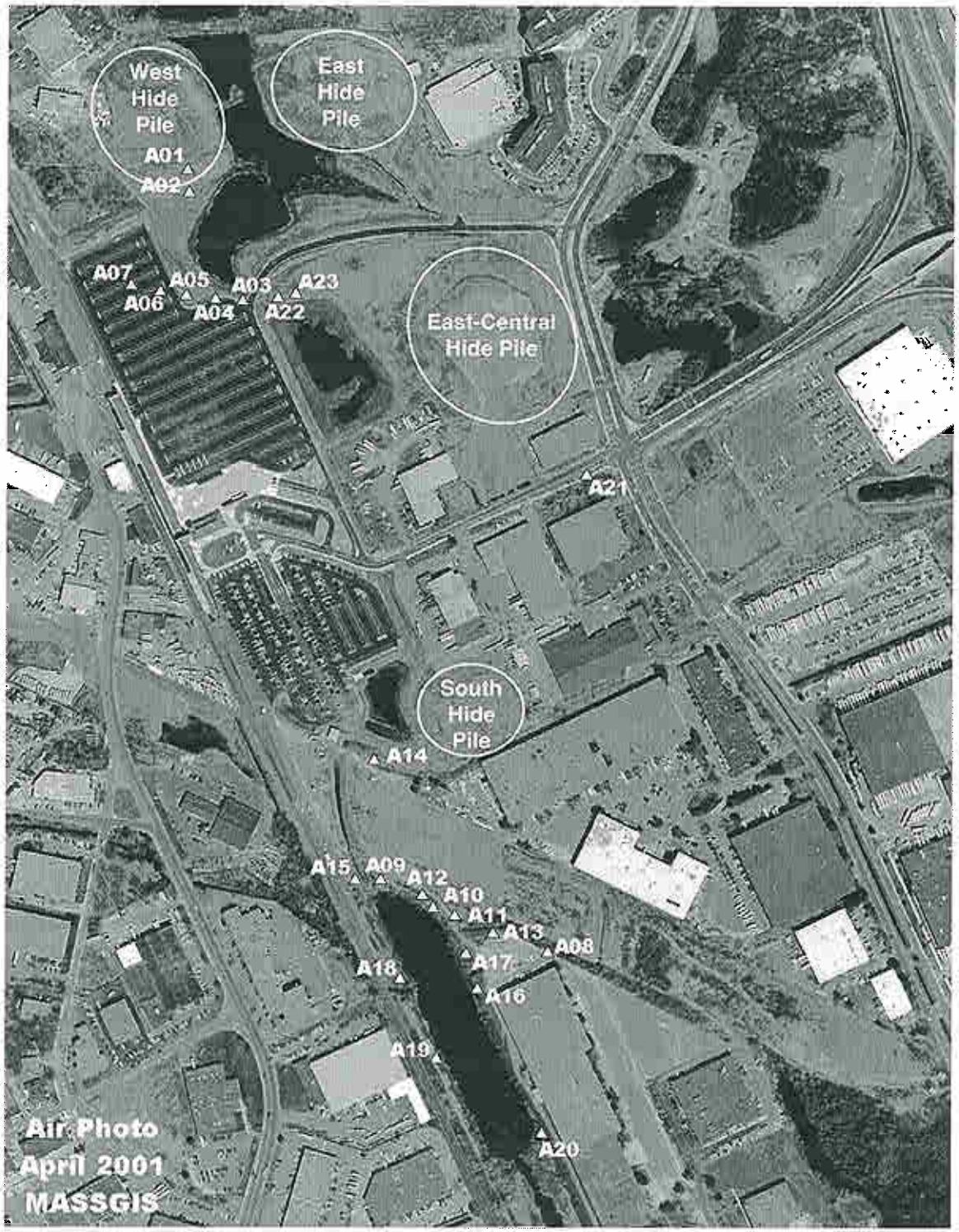


Figure 2. Fixed ground water monitoring locations for the Industri-Plex Site and GSIP Study Area. Image was derived from April 2001 aerial photograph obtained from MassGIS.

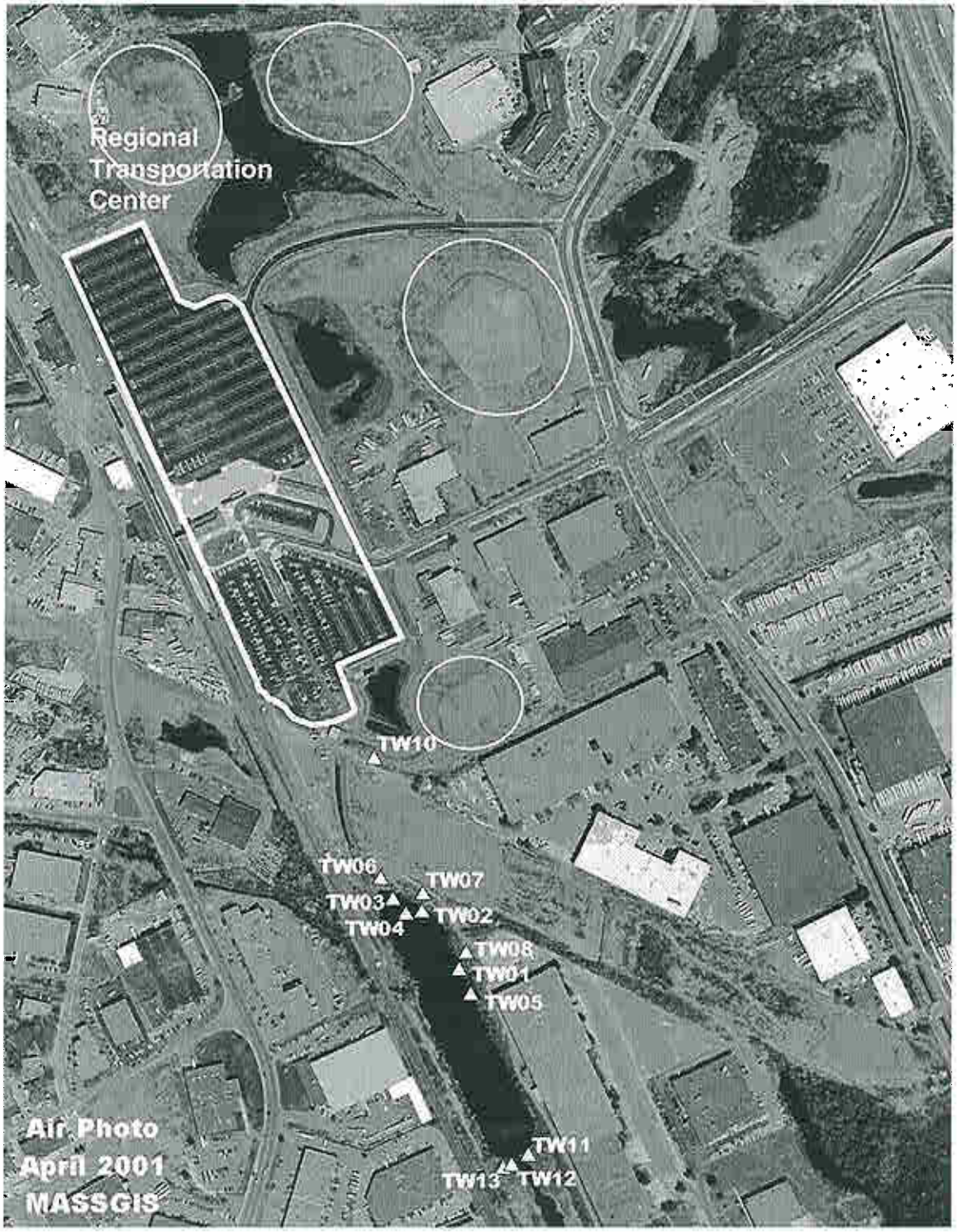
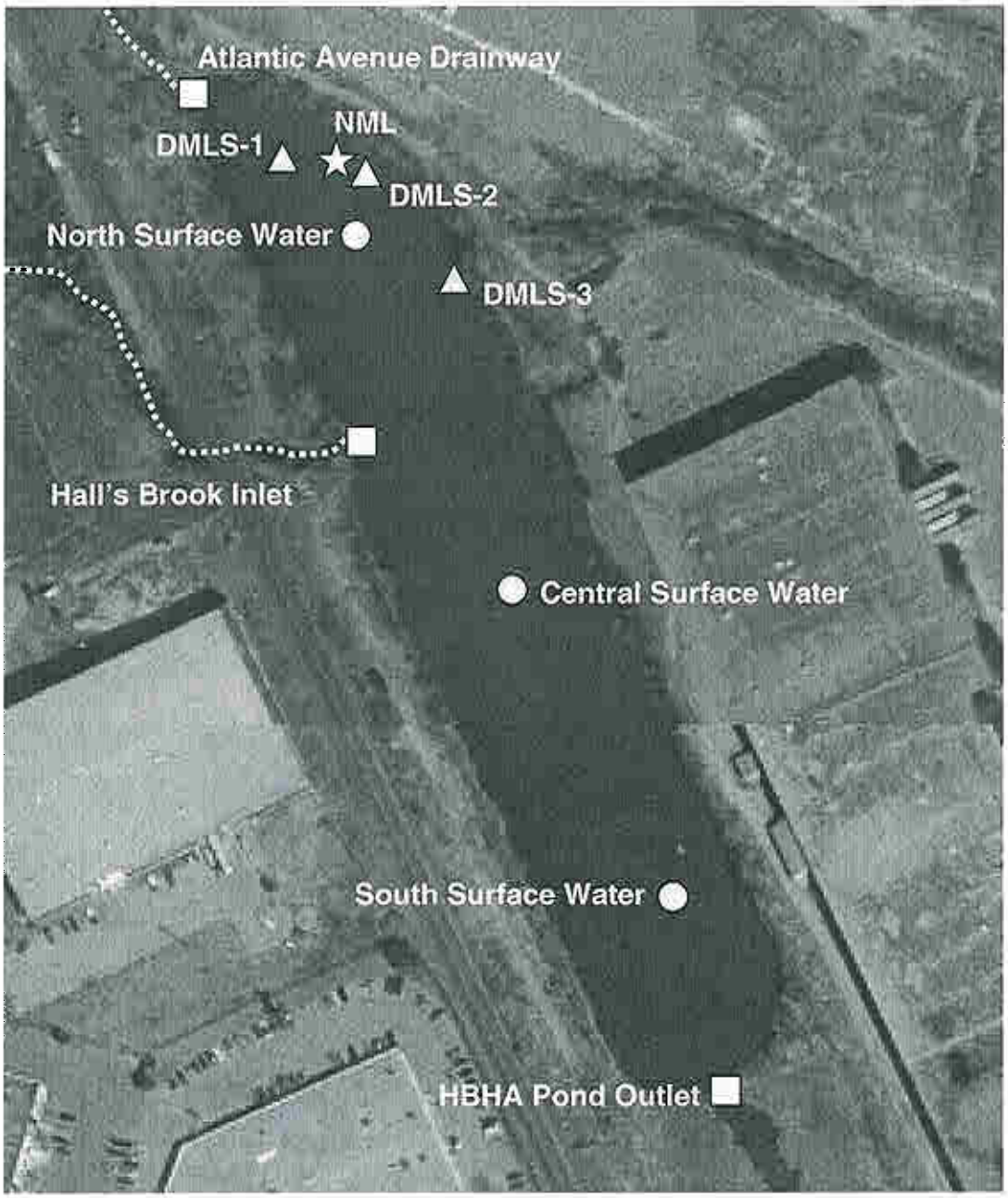


Figure 3. Surface water and sediment porewater monitoring locations within the Hall's Brook Holding Area Pond. Image was derived from November 1995 aerial photograph obtained from MassGIS.



APPENDIX B

JULY 2005 SURFACE WATER AND SOIL SAMPLE RESULTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 Congress Street, Suite 1100
BOSTON, MA 02114-2023

Memorandum

Date: August 16, 2005

Subject: Industri-Plex Sampling Results

From: Jason Turgeon, OES

To: Joe LeMay, OSRR

CC: Rich Fisher, OEME

Joe,

Enclosed are the sampling results from our water sampling in the Halls Pond watershed on July 11, 2005, and our soil sampling in the Rifle Club area on July 12, 2005.

The sampling results are compiled in two tables for quick reference, and accompanied by aerial maps detailing the sampling locations. Also enclosed are copies of the sampling log. Following these are the complete analytical reports from Chelmsford. If you would like the tables and maps in an electronic format, please let me know. You can reach me at 8-1634.

Jason

Industri-Plex Water Sampling Results, Halls Pond Watershed Area
Sampling Date: July 11, 2005

	Analyte (mg/L)								
Sample ID	Bromide	Chloride	Fluoride	Nitrate	Nitrite	Sulfate	Nitrate (N)	Nitrite (N)	o-Phospate (P)
CULV-01	ND<0.50	40	ND<0.50	5.9	0.15	24	1.3	0.05	ND<0.03
COMB-01	ND<0.50	103*	ND<0.50	3.6	ND<0.10	23	0.81	ND<0.03	ND<0.03
OUTLET-01	ND<0.50	83*	ND<0.50	2.4	ND<0.10	31	0.54	ND<0.03	ND<0.03
185NB-HALLS-01	ND<0.50	104*	ND<0.50	2.6	ND<0.10	12	0.59	ND<0.03	ND<0.03
185NB-RR01	ND<0.50	105*	0.6	7.2	0.21	61*	1.6	0.06	ND<0.03
LANDFILL-LF01	ND<0.50	130*	ND<0.50	2.7	0.24	38	0.61	0.07	ND<0.03
LANDFILL-LF02	ND<0.50	131*	ND<0.50	4.0	0.39	39	0.90	0.12	ND<0.03
LANDFILL-RR02	ND<0.50	112*	0.6	5.6	0.18	58*	1.3	0.05	ND<0.03
RR03	ND<0.50	86*	1.1	4.1	ND<0.10	85*	0.93	ND<0.03	ND<0.03
RR04	ND<0.50	92*	ND<0.50	3.0	ND<0.10	24	0.68	ND<0.03	ND<0.03
HALLS-22MAPLE-01	ND<0.50	108*	ND<0.50	2.9	ND<0.10	12	0.65	ND<0.03	ND<0.03
HALLS-20THIRD-01	ND<0.50	105*	ND<0.50	2.2	ND<0.10	11	0.50	ND<0.03	ND<0.03

* Estimated value, outside calibration curve
ND<0.50 = Not Detected at a reporting limit of 0.50 mg/L

Note: For clarity, the prefix "IP" has been removed from sample ID's.

Industri-Plex Soil Sampling Results, Rifle Club Area **Sampling Date: July 12, 2005**

Analyte (mg/Kg)

Sample ID	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
RC-01	4600	ND<9.8	ND<20	56	ND<0.98	ND<2.9	2300	13	11	20	5700	69	830	1600	9.5	ND<390	ND<9.8	ND<2.9	ND<200	ND<20	14	53
RC-02	9100	ND<15	ND<30	48	ND<1.5	ND<4.5	8000	21	4.7	21	11000	140	1400	94	11	ND<600	ND<15	ND<4.5	ND<300	ND<30	35	79
RC-03	9000	ND<16	ND<32	48	ND<1.6	ND<4.8	3700	26	5	79	20000	240	690	33	11	ND<640	ND<16	ND<4.8	ND<320	ND<32	48	97
RC-04	3800	ND<16	ND<32	40	ND<1.6	ND<4.8	4800	17	ND<4.8	12	7900	250	370	24	ND<9.6	ND<640	ND<16	ND<4.8	640	ND<32	24	45
RC-05	8300	ND<12	ND<24	37	ND<1.2	ND<3.2	9400	22	3.9	21	7700	370	620	23	7.3	490	ND<12	ND<3.6	ND<240	ND<24	37	41
RC-06	3100	ND<10	ND<20	21	ND<1.0	ND<3.1	720	17	ND<3.1	16	4300	280	190	9.3	6.2	ND<410	ND<10	ND<3.1	ND<200	ND<20	28	23
RC-07	2900	ND<11	ND<22	13	ND<1.1	ND<3.3	98	3.7	ND<3.3	4	2900	52	69	3.8	ND<6.6	ND<440	ND<11	ND<3.3	ND<220	ND<22	9.5	5.8
RC-08	5400	ND<13	ND<26	73	ND<1.3	ND<3.9	6000	12	7.6	21	6400	200	1000	37	11	530	ND<13	ND<3.9	ND<260	ND<26	18	64
RC-09	3100	ND<10	ND<20	40	ND<1.0	ND<3.0	5400	12	ND<3.0	19	6700	240	360	33	6.6	ND<400	ND<10	ND<3.0	ND<200	ND<20	21	56
RC-10	13000	ND<11	ND<23	17	ND<1.1	ND<3.4	440	16	4.6	17	7300	190	690	24	7.2	ND<460	ND<11	ND<3.4	ND<230	ND<40	40	33
RC-11	2200	12	ND<20	7	ND<0.99	ND<3.0	130	8.4	ND<3.0	11	3600	160	85	6.4	ND<5.9	ND<400	ND<9.9	ND<3.0	ND<200	ND<20	28	17
RC-12	7400	ND<9.7	ND<19	30	ND<0.97	ND<2.9	2700	18	21	26	17000	55	3100	790	14	520	ND<9.7	ND<2.9	ND<190	ND<40	24	84

* Estimated value, outside calibration curve
ND<15 = Not Detected at a reporting limit of 15 mg/Kg

Note: For clarity, the prefix "IP" has been removed from sample ID's.

EPA New England

DRAFT Aug 12th, 2005

Sampling Points
Landfills
Municipal Boundaries
Railroad

Roads
Major
Local

Hydro
Streams
Intermittent Streams

Inset

Industri-Plex Water Sampling
Halls Pond Watershed
Woburn, MA

0 500 1,000 1,500 Feet
0 150 300 450 Meters

N

1 inch equals 928 feet

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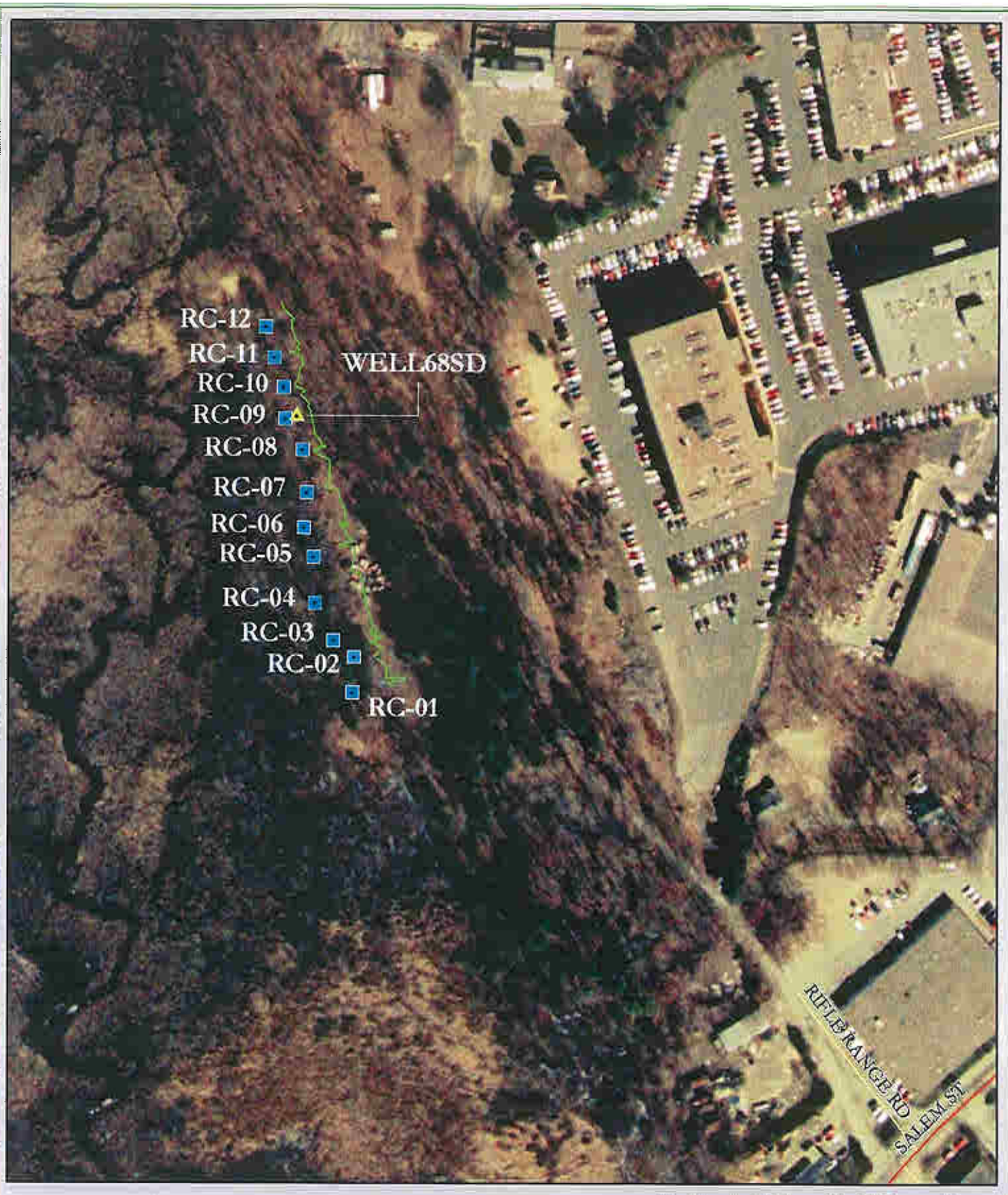

EPA New England

DRAFT August 12th, 2005

Rifle Club Path
Sampling Points
Well

Roads
Major
Local

Area of Detail

Reading
Woburn
Stoneham

Inset

Industri-Plex Soil Sampling
Rifle Club Area

Woburn, MA

100 0 100 200 Feet

25 0 25 50 Meters

N

1 inch equals 160 feet

L:\Projects\Industriplex\ProjectFiles\Industriplex_South.mxd

ALPHA ANALYTICAL LABORATORIES

Eight Walkup Drive
Westborough, Massachusetts 01581-1019
(508) 898-9220 www.alphalab.com

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

CERTIFICATE OF ANALYSIS

Client: U.S. EPA **Laboratory Job Number:** L0507683

Address: N.E. Regional Lab-Office of Env. Meas.
11 Technology Drive
North Chelmsford, MA 01863-2431 **Date Received:** 12-JUL-2005

Attn: Mr. Dan Boudreau **Date Reported:** 26-JUL-2005

Project Number: 05070015 **Delivery Method:** Alpha

Site: INDUSTRI- PLEX

ALPHA SAMPLE NUMBER	CLIENT IDENTIFICATION	SAMPLE LOCATION
L0507683-01	IP-CULV-01	
L0507683-02	IP-COMB-01	
L0507683-03	IP-OUTLET-01	
L0507683-04	IP-185NB-HALLS-01	
L0507683-05	IP-185NB-HALLS-01D	
L0507683-06	IP-185NB-RR01	
L0507683-07	IP-185NB-RR01D	
L0507683-08	IP-LANDFILL-LF01	
L0507683-09	IP-LANDFILL-LF02	
L0507683-10	IP-LANDFILL-RR02	
L0507683-11	IP-RR03	
L0507683-12	IP-RR04	
L0507683-13	IP-HALLS-22 MAPLE-01	
L0507683-14	IP-HALLS-20 THIRD-01	

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized by: Douglas Sheeley
This document electronically signed

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-01
IP-CULV-01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 10:30
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	8.03	mg/l	0.075	44 350.1	0721 17:30	0722 12:14	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-02
IP-COMB-01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 11:20
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	2.10	mg/l	0.075	44 350.1	0721 17:30	0722 12:15	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-03
IP-OUTLET-01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 12:15
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	3.81	mg/l	0.075	44 350.1	0721 17:30	0722 12:19	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-04
IP-185NB-HALLS-01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 13:15
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 2-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	ND	mg/l	0.075	44 350.1	0721 17:30	0722 12:20	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-05
IP-185NB-HALLS-01D
Sample Matrix: WATER

Date Collected: 11-JUL-2005 13:15
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	ND	mg/l	0.075	44 350.1	0721 17:30	0722 12:22	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-06
IP-185NB-RR01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 13:25
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 2-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	9.97	mg/l	0.075	44 350.1	0721 17:30	0722 12:23	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-07
IP-185NB-RR01D
Sample Matrix: WATER

Date Collected: 11-JUL-2005 13:25
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory
Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	10.1	mg/l	0.075	44 350.1	0721 17:30	0722 12:25	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-08
IP-LANDFILL-LF01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 14:30
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	12.7	mg/l	0.075	44 350.1	0721 17:30	0722 12:25	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-09
IP-LANDFILL-LF02
Sample Matrix: WATER

Date Collected: 11-JUL-2005 15:00
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	11.0	mg/l	0.075	44 350.1	0721 17:30	0722 12:26	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-10
IP-LANDFILL-RR02
Sample Matrix: WATER

Date Collected: 11-JUL-2005 14:15
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	11.3	mg/l	0.075	44 350.1	0721 17:30	0722 12:31	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-11
IP-RR03
Sample Matrix: WATER

Date Collected: 11-JUL-2005 15:35
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	10.8	mg/l	0.075	44 350.1	0721 17:30	0722 12:31	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-12
IP-RR04
Sample Matrix: WATER

Date Collected: 11-JUL-2005 16:05
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	0.275	mg/l	0.075	44 350.1	0721 17:30	0722 12:32	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-13
IP-HALLS-22 MAPLE-01
Sample Matrix: WATER

Date Collected: 11-JUL-2005 16:55
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005

Condition of Sample: Satisfactory

Field Prep: None

Number & Type of Containers: 1-Plastic

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	ND	mg/l	0.075	44 350.1	0721 17:30	0722 12:33	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

MA:M-MA086 NH:200301-A CT:PH-0574 ME:MA086 RI:65 NY:11148 NJ:MA935 Army:USACE

Laboratory Sample Number: L0507683-14 IP-HALLS-20 THIRD-01
Sample Matrix: WATER
Condition of Sample: Satisfactory
Number & Type of Containers: 1-Plastic

Date Collected: 11-JUL-2005 17:15
Date Received : 12-JUL-2005
Date Reported : 26-JUL-2005
Field Prep: None

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Nitrogen, Ammonia	ND	mg/l	0.075	44 350.1	0721 17:30	0722 12:34	AT

Comments: Complete list of References and Glossary of Terms found in Addendum I

ALPHA ANALYTICAL LABORATORIES
QUALITY ASSURANCE BATCH DUPLICATE ANALYSIS

Laboratory Job Number: L0507683

Parameter	Value 1	Value 2	Units	RPD	RPD Limits
Nitrogen, Ammonia for sample(s) 01-14 (L0507683-04, WG208238-4)					
Nitrogen, Ammonia	ND	ND	mg/l	NC	

ALPHA ANALYTICAL LABORATORIES
QUALITY ASSURANCE BATCH SPIKE ANALYSES

Laboratory Job Number: L0507683

Parameter	% Recovery	QC Criteria
Nitrogen, Ammonia LCS for sample(s) 01-14 (WG208238-2)		
Nitrogen, Ammonia	96	
Nitrogen, Ammonia SPIKE for sample(s) 01-14 (L0507683-06, WG208238-3)		
Nitrogen, Ammonia	98	

ALPHA ANALYTICAL LABORATORIES
QUALITY ASSURANCE BATCH BLANK ANALYSIS

Laboratory Job Number: L0507683

PARAMETER	RESULT	UNITS	RDL	REF METHOD	DATE PREP	DATE ANAL	ID
Blank Analysis for sample(s) 01-14 (WG208238-1)							
Nitrogen, Ammonia	ND	mg/l	0.075	44 350.1	0721 17:30	0722 12:08	AT

REFERENCES

44. Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, August 1993.

GLOSSARY OF TERMS AND SYMBOLS

REF	Reference number in which test method may be found.
METHOD	Method number by which analysis was performed.
ID	Initials of the analyst.
ND	Not detected in comparison to the reported detection limit.
NI	Not Ignitable.
ug/cart	Micrograms per Cartridge.

LIMITATION OF LIABILITIES

Alpha Analytical, Inc. performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical, Inc., shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical, Inc. be held liable for any incidental consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical, Inc.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding times and splitting of samples in the field.

ENVIRONMENTAL PROTECTION AGENCY

REGION 1

ALPHA Job # L0507683

CHAIN OF CUSTODY RECORD

TO ALPHA ANALYTICAL LAB.

PROJ. NO.	PROJECT NAME
05070015	INDUSTRI-PLEX.

SAMPLERS: *(Signature)* RICH FISHER, MIKE LOONEY, JASON TURGEON

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	AMMONIA	REMARKS
	7/11/05	10:30		✓	IP - CULV - 01	1	✓	PRESERVED WITH H_2SO_4 & ICE
		11:20		✓	IP - COMB - 01	1	✓	
		12:15		✓	IP - OUTLET - 01	1	✓	
		13:15		✓	IP - 185NB - HALLS - 01	2	✓	MS / MSD
		13:15		✓	IP - 185NB - HALLS - 01D	1	✓	
		13:25		✓	IP - 185 NB - RR01	2	✓	MS / MSD
		13:25		✓	IP - 185 NB - RR01D	1	✓	
		14:30		✓	IP - LANDFILL - LF01	1	✓	
		15:00		✓	IP - LANDFILL - LF02	1	✓	
		14:15		✓	IP - LANDFILL - RR02	1	✓	
		15:35		✓	IP - RR03	1	✓	
		16:05		✓	IP - RR04	1	✓	
		16:55		✓	IP - HALLS - 22MAPLE - 01	1	✓	
	↓	17:15		✓	IP - HALLS - 20THIRD - 01	1	✓	

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
	07-12-05 15:39				
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
	7/12/05 16:40				
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

1-14778

United States Environmental Protection Agency
Office of Environmental Measurement & Evaluation
11 Technology Drive
North Chelmsford, MA 01863-2431

Laboratory Report

July 20, 2005

Joseph LeMay - HBO
US EPA New England Region 1
One Congress Street
Boston, MA 02114 - 2023

Project Number: 05070015
Project: Industri-Plex - Woburn, MA
Analysis: Ion Chromatography Anions
Analyst: Inna Germansderfer IG 7/20/05

Analytical Procedure:

All samples were received and logged in by the laboratory according to the USEPA New England Laboratory SOP for Sample Log-in.

Samples were analyzed following the EPA Region I SOP, EIASOP-INGDXIC8.

The analysis was performed using either a Dionex DX320 or DX120 Ion Chromatograph.

Date Samples Received by the Laboratory: 7/12/05

If you have any questions please call me at 617-918-8602 .

Sincerely,

Peter Philbrook Peter Philbrook 7-21-05
Chemistry Laboratory Services Coordinator

Qualifiers:

RL = Reporting limit
ND = Not Detected above reporting limit
NA = Not Applicable
NC = Not calculated since analyte concentration is ND
J1 = Estimated value due to MS recovery outside accceptance criteria
J2 = Estimated value due to LFB result outside acceptance criteria
J3 = Estimated value due to RPD result outside acceptance criteria
J4 = Estimated value due to LCS result outside acceptance criteria
B = Analyte is associated with the lab blank or trip blank contamination. Values are qualified when the observed concentration of the contamination in the sample extract is less than 10 times the concentration in the blank.
R = No recovery was calculated since the analyte concentration is greater than four times the spike level.

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-CULV-01	Lab Sample ID:	AA51244
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**40**	0.10	
	Fluoride	ND	0.50	
	Nitrate	**5.9**	0.10	
	Nitrite	**0.15**	0.10	
	Sulfate	**24**	0.10	

Comments:

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**1.3**	0.02	
	Nitrite as Nitrogen	**0.05**	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-COMB-01	Lab Sample ID:	AA51245
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**103**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**3.6**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**23**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.81**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-OUTLET-01	Lab Sample ID:	AA51246
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**83**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**2.4**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**31**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.54**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-185NB-HALLS-01	Lab Sample ID:	AA51247
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**104**	0.50	J
	Fluoride	ND	0.50	
	Nitrate	**2.6**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**12**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.59**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-185NB-HALLS-01D	Lab Sample ID:	AA51248
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**104**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**2.6**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**12**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.59**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-185NB-RR01	Lab Sample ID:	AA51249
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**105**	0.10	J
	Fluoride	**0.60**	0.50	
	Nitrate	**7.2**	0.10	
	Nitrite	**0.21**	0.10	
	Sulfate	**61**	0.10	J

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**1.6**	0.02	
	Nitrite as Nitrogen	**0.06**	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-185NB-RR01D	Lab Sample ID:	AA51250
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**105**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**7.2**	0.10	
	Nitrite	**0.22**	0.10	
	Sulfate	**61**	0.10	J

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**1.6**	0.02	
	Nitrite as Nitrogen	**0.07**	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-LANDFILL-LF01	Lab Sample ID:	AA51251
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**130**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**2.7**	0.10	
	Nitrite	**0.24**	0.10	
	Sulfate	**38**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.61**	0.02	
	Nitrite as Nitrogen	**0.07**	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-LANDFILL-LF02	Lab Sample ID:	AA51252
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/13/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**131**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**4.0**	0.10	
	Nitrite	**0.39**	0.10	
	Sulfate	**39**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.90**	0.02	
	Nitrite as Nitrogen	**0.12**	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-LANDFILL-RR02	Lab Sample ID:	AA51253
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/13/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**112**	0.10	J
	Fluoride	**0.60**	0.50	
	Nitrate	**5.6**	0.10	
	Nitrite	**0.18**	0.10	
	Sulfate	**58**	0.10	J

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**1.3**	0.02	
	Nitrite as Nitrogen	**0.05**	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-RR03	Lab Sample ID:	AA51254
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/13/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**86**	0.10	J
	Fluoride	**1.1**	0.50	
	Nitrate	**4.1**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**85**	0.10	J

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.93**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-RR04	Lab Sample ID:	AA51255
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/13/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**92**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**3.0**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**24**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.68**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-HALLS-22MAPLE-01	Lab Sample ID:	AA51256
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/13/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**108**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**2.9**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**12**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.65**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Ion Chromatography Anions

Client Sample ID:	IP-HALLS-20THIRD-01	Lab Sample ID:	AA51257
Date of Collection:	7/11/2005	Matrix	Water
Date of Analysis:	7/13/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	**105**	0.10	J
	Fluoride	ND	0.50	
	Nitrate	**2.2**	0.10	
	Nitrite	ND	0.10	
	Sulfate	**11**	0.10	

Comments: J- estimated value, outside calibration curve

NO2NO3 as Nitrogen / PO4 as Phosphorus

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Nitrate as Nitrogen	**0.50**	0.02	
	Nitrite as Nitrogen	ND	0.03	
	o-Phosphate as Phosphorus	ND	0.03	

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Laboratory Blank

Client Sample ID:	N/A	Lab Sample ID:	N/A
Date of Collection:	N/A	Matrix	Water
Date of Analysis:	7/12/05		

CAS Number	Parameter	Concentration mg/L	RL mg/L	Qualifier
	Bromide	ND	0.50	
	Chloride	ND	0.10	
	Fluoride	ND	0.50	
	Nitrate	ND	0.10	
	Nitrite	ND	0.10	
	Sulfate	ND	0.10	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

MATRIX SPIKE (MS) RESULTS

Industri-Plex - Woburn, MA

COMPOUND	SPIKE ADDED mg/L	SAMPLE CONCENTRATION mg/L	MS CONCENTRATION mg/L	MS % REC	QC LIMITS (% REC)
Sample ID: AA51247					
Bromide	5	ND	5.2	104	80 - 120
Chloride	1.5	104	99	R	80 - 120
Fluoride	1	ND	1.0	100	80 - 120
Nitrate	5	2.6	7.7	105	80 - 120
Nitrite	5	ND	6.1	122	80 - 120
Sulfate	7.5	12	19	101	80 - 120
Sample ID: AA51249					
Bromide	5	ND	5.4	108	80 - 120
Chloride	1.5	105	100	R	80 - 120
Fluoride	1	0.6	1.7	113	80 - 120
Nitrate	5	7.2	12	103	80 - 120
Nitrite	5	0.21	5.7	110	80 - 120
Sulfate	7.5	61	64	R	80 - 120

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

LABORATORY DUPLICATE RESULTS

Industri-Plex - Woburn, MA

COMPOUND	SAMPLE RESULT mg/L	SAMPLE DUPLICATE RESULT mg/L	PRECISION RPD %	QC LIMITS RPD (%)
Sample ID: AA51244				
Bromide	ND	ND	ND	20
Chloride	40	40	0.0	20
Fluoride	ND	ND	ND	20
Nitrate	5.9	5.9	0.0	20
Nitrite	0.15	0.16	6.5	20
Sulfate	24	24	0.0	20
Sample ID: AA51254				
Bromide	ND	ND	ND	20
Chloride	86	88	2.3	20
Fluoride	1.1	1.2	8.7	20
Nitrate	4.1	4.1	0.0	20
Nitrite	ND	ND	ND	20
Sulfate	85	85	0.0	20

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Laboratory Fortified Blank (LFB) Results

Industri-Plex - Woburn, MA

COMPOUND	LFB AMOUNT SPIKED mg/L	LFB RESULT mg/L	LFB RECOVERY %	QC LIMITS %
Bromide	5	5.0	100	90 - 110
Chloride	1.5	1.4	93	90 - 110
Fluoride	1	0.90	90	90 - 110
Nitrate	5	5.1	102	90 - 110
Nitrite	5	4.8	96	90 - 110
Sulfate	7.5	7.7	103	90 - 110

Samples in Batch: AA51244, AA51245, AA51246, AA51247, AA51248, AA51249, AA51250, AA51251, AA51252, AA51253, AA51254, AA51255, AA51256, AA51257

EPA
Region 1, New England

United States Environmental Protection Agency
Office of Environmental Measurement & Evaluation
11 Technology Drive
North Chelmsford, MA 01863-2431

Laboratory Report

July 26, 2005

Joseph LeMay - HBO
US EPA New England Region 1
One Congress Street
Boston, MA 02114 - 2023

Project Number: 05070017
Project: Industri-Plex - Woburn, MA
Analysis: Metals in Soil Medium Level by ICP
EPA Chemist: Mike Dowling
MD 7/28/05

Analytical Procedure:

All samples were received and logged in by the laboratory according to the USEPA New England Laboratory SOP for Sample Log-in.

Samples were prepared following the EPA Region I SOP, INGMETALSPREP5.SOP.

Samples were analyzed following the EPA Region I SOP, EIASOP-INGICP6.

Samples were analyzed by inductively coupled plasma - atomic emission spectrometry using pneumatic nebulization. Preparation and analysis SOP's are based on "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Revision 2, Final Update III, Methods 3050B and 6010B," respectively.

Date Samples Received by the Laboratory: 7/12/05

If you have any questions, please call me at 617-918-8602.

Sincerely,

Peter Philbrook Peter Philbrook 7-28-05
Chemistry Laboratory Services Coordinator

Qualifiers:

RL	Reporting limit
ND	Not Detected above reporting limit
NA	Not Applicable
NC	Not calculated since analyte concentration is ND
J1	Estimated value due to MS recovery outside accceptance criteria
J2	Estimated value due to LFB result outside acceptance criteria
J3	Estimated value due to RPD result outside acceptance criteria
J4	Estimated value due to LCS result outside acceptance criteria
J5	Estimated value due to interference check recovery outside accceptance criteria
B	Analyte is associated with the lab blank or trip blank contamination. Values are qualified when the observed concentration of the contamination in the sample extract is less than 10 times the concentration in the blank.
R	No recovery was calculated since the analyte concentration is greater than four times the spike level.

Comments:

The samples were prepared and analyzed by ESAT contractors.

Sample results are in mg/Kg dry wt. units.

US ENVIRONMENTAL PROTECTION AGENCY
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Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-01	Lab Sample ID:	AA51321
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**4600**	20	
7440-36-0	Antimony	ND	9.8	
7440-38-2	Arsenic	ND	20	
7440-39-3	Barium	**56**	2.9	
7440-41-7	Beryllium	ND	0.98	
7440-43-9	Cadmium	ND	2.9	
7440-70-2	Calcium	**2300**	20	
7440-47-3	Chromium	**13**	2.9	
7440-48-4	Cobalt	**11**	2.9	
7440-50-8	Copper	**20**	2.9	
7439-89-6	Iron	**5700**	9.8	
7439-92-1	Lead	**69**	9.8	
7439-95-4	Magnesium	**830**	20	
7439-96-5	Manganese	**1600**	2.0	
7440-02-0	Nickel	**9.5**	5.9	
7440-09-7	Potassium	ND	390	
7782-49-2	Selenium	ND	9.8	
7440-22-4	Silver	ND	2.9	
7440-23-5	Sodium	ND	200	
7440-28-0	Thallium	ND	20	
7440-62-2	Vanadium	**14**	2.9	
7440-66-6	Zinc	**53**	2.9	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-02	Lab Sample ID:	AA51322
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**9100**	30	
7440-36-0	Antimony	ND	15	
7440-38-2	Arsenic	ND	30	
7440-39-3	Barium	**48**	4.5	
7440-41-7	Beryllium	ND	1.5	
7440-43-9	Cadmium	ND	4.5	
7440-70-2	Calcium	**8000**	30	
7440-47-3	Chromium	**21**	4.5	
7440-48-4	Cobalt	**4.7**	4.5	
7440-50-8	Copper	**29**	4.5	
7439-89-6	Iron	**13000**	15	
7439-92-1	Lead	**140**	15	
7439-95-4	Magnesium	**900**	30	
7439-96-5	Manganese	**94**	3.0	
7440-02-0	Nickel	**11**	8.9	
7440-09-7	Potassium	ND	600	
7782-49-2	Selenium	ND	15	
7440-22-4	Silver	ND	4.5	
7440-23-5	Sodium	ND	300	
7440-28-0	Thallium	ND	30	
7440-62-2	Vanadium	**36**	4.5	
7440-66-6	Zinc	**79**	4.5	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-03	Lab Sample ID:	AA51323
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**9000**	32	
7440-36-0	Antimony	ND	16	
7440-38-2	Arsenic	ND	32	
7440-39-3	Barium	**48**	4.8	
7440-41-7	Beryllium	ND	1.6	
7440-43-9	Cadmium	ND	4.8	
7440-70-2	Calcium	**3700**	32	
7440-47-3	Chromium	**26**	4.8	
7440-48-4	Cobalt	**5.0**	4.8	
7440-50-8	Copper	**79**	4.8	
7439-89-6	Iron	**20000**	16	
7439-92-1	Lead	**240**	16	
7439-95-4	Magnesium	**690**	32	
7439-96-5	Manganese	**33**	3.2	
7440-02-0	Nickel	**11**	9.7	
7440-09-7	Potassium	ND	640	
7782-49-2	Selenium	ND	16	
7440-22-4	Silver	ND	4.8	
7440-23-5	Sodium	ND	320	
7440-28-0	Thallium	ND	32	
7440-62-2	Vanadium	**48**	4.8	
7440-66-6	Zinc	**57**	4.8	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-04	Lab Sample ID:	AA51324
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**3800**	32	
7440-36-0	Antimony	ND	16	
7440-38-2	Arsenic	ND	32	
7440-39-3	Barium	**40**	4.8	
7440-41-7	Beryllium	ND	1.6	
7440-43-9	Cadmium	ND	4.8	
7440-70-2	Calcium	**4800**	32	
7440-47-3	Chromium	**17**	4.8	
7440-48-4	Cobalt	ND	4.8	
7440-50-8	Copper	**22**	4.8	
7439-89-6	Iron	**7800**	16	
7439-92-1	Lead	**250**	16	
7439-95-4	Magnesium	**370**	32	
7439-96-5	Manganese	**24**	3.2	
7440-02-0	Nickel	ND	9.6	
7440-09-7	Potassium	ND	640	
7782-49-2	Selenium	ND	16	
7440-22-4	Silver	ND	4.8	
7440-23-5	Sodium	**640**	320	
7440-28-0	Thallium	ND	32	
7440-62-2	Vanadium	**24**	4.8	
7440-66-6	Zinc	**45**	4.8	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-05	Lab Sample ID:	AA51325
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**8300**	24	
7440-36-0	Antimony	ND	12	
7440-38-2	Arsenic	ND	24	
7440-39-3	Barium	**37**	3.6	
7440-41-7	Beryllium	ND	1.2	
7440-43-9	Cadmium	ND	3.6	
7440-70-2	Calcium	**9400**	24	
7440-47-3	Chromium	**22**	3.6	
7440-48-4	Cobalt	**3.9**	3.6	
7440-50-8	Copper	**21**	3.6	
7439-89-6	Iron	**7700**	12	
7439-92-1	Lead	**370**	12	
7439-95-4	Magnesium	**620**	24	
7439-96-5	Manganese	**23**	2.4	
7440-02-0	Nickel	**7.3**	7.2	
7440-09-7	Potassium	**490**	480	
7782-49-2	Selenium	ND	12	
7440-22-4	Silver	ND	3.6	
7440-23-5	Sodium	ND	240	
7440-28-0	Thallium	ND	24	
7440-62-2	Vanadium	**37**	3.6	
7440-66-6	Zinc	**41**	3.6	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-06	Lab Sample ID:	AA51326
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**3100**	20	
7440-36-0	Antimony	ND	10	
7440-38-2	Arsenic	ND	20	
7440-39-3	Barium	**21**	3.1	
7440-41-7	Beryllium	ND	1.0	
7440-43-9	Cadmium	ND	3.1	
7440-70-2	Calcium	**720**	20	
7440-47-3	Chromium	**17**	3.1	
7440-48-4	Cobalt	ND	3.1	
7440-50-8	Copper	**16**	3.1	
7439-89-6	Iron	**4300**	10	
7439-92-1	Lead	**280**	10	
7439-95-4	Magnesium	**150**	20	
7439-96-5	Manganese	**9.3**	2.0	
7440-02-0	Nickel	**6.2**	6.1	
7440-09-7	Potassium	ND	410	
7782-49-2	Selenium	ND	10	
7440-22-4	Silver	ND	3.1	
7440-23-5	Sodium	ND	200	
7440-28-0	Thallium	ND	20	
7440-62-2	Vanadium	**28**	3.1	
7440-66-6	Zinc	**23**	3.1	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-07	Lab Sample ID:	AA51327
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**2900**	22	
7440-36-0	Antimony	ND	11	
7440-38-2	Arsenic	ND	22	
7440-39-3	Barium	**13**	3.3	
7440-41-7	Beryllium	ND	1.1	
7440-43-9	Cadmium	ND	3.3	
7440-70-2	Calcium	**98**	22	
7440-47-3	Chromium	**3.7**	3.3	
7440-48-4	Cobalt	ND	3.3	
7440-50-8	Copper	**4.0**	3.3	
7439-89-6	Iron	**2900**	11	
7439-92-1	Lead	**52**	11	
7439-95-4	Magnesium	**69**	22	
7439-96-5	Manganese	**3.8**	2.2	
7440-02-0	Nickel	ND	6.6	
7440-09-7	Potassium	ND	440	
7782-49-2	Selenium	ND	11	
7440-22-4	Silver	ND	3.3	
7440-23-5	Sodium	ND	220	
7440-28-0	Thallium	ND	22	
7440-62-2	Vanadium	**9.5**	3.3	
7440-66-6	Zinc	**5.8**	3.3	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-08	Lab Sample ID:	AA51328
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**5400**	26	
7440-36-0	Antimony	ND	13	
7440-38-2	Arsenic	ND	26	
7440-39-3	Barium	**73**	3.9	
7440-41-7	Beryllium	ND	1.3	
7440-43-9	Cadmium	ND	3.9	
7440-70-2	Calcium	**6000**	26	
7440-47-3	Chromium	**12**	3.9	
7440-48-4	Cobalt	**7.6**	3.9	
7440-50-8	Copper	**21**	3.9	
7439-89-6	Iron	**6400**	13	
7439-92-1	Lead	**200**	13	
7439-95-4	Magnesium	**1000**	26	
7439-96-5	Manganese	**37**	2.6	
7440-02-0	Nickel	**11**	7.9	
7440-09-7	Potassium	**530**	520	
7782-49-2	Selenium	ND	13	
7440-22-4	Silver	ND	3.9	
7440-23-5	Sodium	ND	260	
7440-28-0	Thallium	ND	26	
7440-62-2	Vanadium	**18**	3.9	
7440-66-6	Zinc	**64**	3.9	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-10	Lab Sample ID:	AA51329
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**13000**	23	
7440-36-0	Antimony	ND	11	
7440-38-2	Arsenic	ND	23	
7440-39-3	Barium	**17**	3.4	
7440-41-7	Beryllium	ND	1.1	
7440-43-9	Cadmium	ND	3.4	
7440-70-2	Calcium	**440**	23	
7440-47-3	Chromium	**16**	3.4	
7440-48-4	Cobalt	**4.6**	3.4	
7440-50-8	Copper	**17**	3.4	
7439-89-6	Iron	**7300**	11	
7439-92-1	Lead	**190**	11	
7439-95-4	Magnesium	**690**	23	
7439-96-5	Manganese	**24**	2.3	
7440-02-0	Nickel	**7.2**	6.8	
7440-09-7	Potassium	ND	460	
7782-49-2	Selenium	ND	11	
7440-22-4	Silver	ND	3.4	
7440-23-5	Sodium	ND	230	
7440-28-0	Thallium	ND	40	
7440-62-2	Vanadium	**40**	3.4	
7440-66-6	Zinc	**33**	3.4	

Comments: The reporting limit for thallium was raised due to matrix interference.

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-11	Lab Sample ID:	AA51330
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**2200**	20	
7440-36-0	Antimony	**12**	9.9	
7440-38-2	Arsenic	ND	20	
7440-39-3	Barium	**7.0**	3.0	
7440-41-7	Beryllium	ND	0.99	
7440-43-9	Cadmium	ND	3.0	
7440-70-2	Calcium	**130**	20	
7440-47-3	Chromium	**8.4**	3.0	
7440-48-4	Cobalt	ND	3.0	
7440-50-8	Copper	**11**	3.0	
7439-89-6	Iron	**3600**	9.9	
7439-92-1	Lead	**160**	9.9	
7439-95-4	Magnesium	**85**	20	
7439-96-5	Manganese	**6.4**	2.0	
7440-02-0	Nickel	ND	5.9	
7440-09-7	Potassium	ND	400	
7782-49-2	Selenium	ND	9.9	
7440-22-4	Silver	ND	3.0	
7440-23-5	Sodium	ND	200	
7440-28-0	Thallium	ND	20	
7440-62-2	Vanadium	**28**	3.0	
7440-66-6	Zinc	**17**	3.0	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-12	Lab Sample ID:	AA51331
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**7400**	19	
7440-36-0	Antimony	ND	9.7	
7440-38-2	Arsenic	ND	19	
7440-39-3	Barium	**30**	2.9	
7440-41-7	Beryllium	ND	0.97	
7440-43-9	Cadmium	ND	2.9	
7440-70-2	Calcium	**2700**	19	
7440-47-3	Chromium	**18**	2.9	
7440-48-4	Cobalt	**21**	2.9	
7440-50-8	Copper	**26**	2.9	
7439-89-6	Iron	**17000**	9.7	
7439-92-1	Lead	**55**	9.7	
7439-95-4	Magnesium	**3100**	19	
7439-96-5	Manganese	**790**	1.9	
7440-02-0	Nickel	**14**	5.8	
7440-09-7	Potassium	**520**	380	
7782-49-2	Selenium	ND	9.7	
7440-22-4	Silver	ND	2.9	
7440-23-5	Sodium	ND	190	
7440-28-0	Thallium	ND	40	
7440-62-2	Vanadium	**24**	2.9	
7440-66-6	Zinc	**84**	2.9	

Comments: The reporting limit for thallium was raised due to matrix interference.

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-08D	Lab Sample ID:	AA51332
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**4900**	20	
7440-36-0	Antimony	ND	9.8	
7440-38-2	Arsenic	ND	20	
7440-39-3	Barium	**78**	2.9	
7440-41-7	Beryllium	ND	0.98	
7440-43-9	Cadmium	ND	2.9	
7440-70-2	Calcium	**5400**	20	
7440-47-3	Chromium	**9.4**	2.9	
7440-48-4	Cobalt	**7.5**	2.9	
7440-50-8	Copper	**20**	2.9	
7439-89-6	Iron	**6600**	9.8	
7439-92-1	Lead	**170**	9.8	
7439-95-4	Magnesium	**600**	20	
7439-96-5	Manganese	**38**	2.0	
7440-02-0	Nickel	**11**	5.9	
7440-09-7	Potassium	**540**	390	
7782-49-2	Selenium	ND	9.8	
7440-22-4	Silver	ND	2.9	
7440-23-5	Sodium	ND	200	
7440-28-0	Thallium	ND	20	
7440-62-2	Vanadium	**16**	2.9	
7440-66-6	Zinc	**67**	2.9	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-09D	Lab Sample ID:	AA51333
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**3900**	20	
7440-36-0	Antimony	ND	10	
7440-38-2	Arsenic	ND	20	
7440-39-3	Barium	**51**	3.0	
7440-41-7	Beryllium	ND	1.0	
7440-43-9	Cadmium	ND	3.0	
7440-70-2	Calcium	**7100**	20	
7440-47-3	Chromium	**16**	3.0	
7440-48-4	Cobalt	**3.7**	3.0	
7440-50-8	Copper	**24**	3.0	
7439-89-6	Iron	**8400**	10	
7439-92-1	Lead	**280**	10	
7439-95-4	Magnesium	**480**	20	
7439-96-5	Manganese	**50**	2.0	
7440-02-0	Nickel	**7.8**	6.0	
7440-09-7	Potassium	ND	400	
7782-49-2	Selenium	ND	10	
7440-22-4	Silver	ND	3.0	
7440-23-5	Sodium	ND	200	
7440-28-0	Thallium	ND	20	
7440-62-2	Vanadium	**26**	3.0	
7440-66-6	Zinc	**73**	3.0	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Metals in Soil Medium Level by ICP

Client Sample ID:	RC-09	Lab Sample ID:	AA51334
Date of Collection:	7/12/2005	Matrix	Soil/Sediment
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	N/A	pH:	N/A

CAS Number	Parameter	Concentration mg/Kg	RL mg/Kg	Qualifier
7429-90-5	Aluminum	**3100**	20	
7440-36-0	Antimony	ND	10	
7440-38-2	Arsenic	ND	20	
7440-39-3	Barium	**40**	3.0	
7440-41-7	Beryllium	ND	1.0	
7440-43-9	Cadmium	ND	3.0	
7440-70-2	Calcium	**5400**	20	
7440-47-3	Chromium	**12**	3.0	
7440-48-4	Cobalt	ND	3.0	
7440-50-8	Copper	**19**	3.0	
7439-89-6	Iron	**6700**	10	
7439-92-1	Lead	**240**	10	
7439-95-4	Magnesium	**360**	20	
7439-96-5	Manganese	**33**	2.0	
7440-02-0	Nickel	**6.6**	6.0	
7440-09-7	Potassium	ND	400	
7782-49-2	Selenium	ND	10	
7440-22-4	Silver	ND	3.0	
7440-23-5	Sodium	ND	200	
7440-28-0	Thallium	ND	20	
7440-62-2	Vanadium	**21**	3.0	
7440-66-6	Zinc	**56**	3.0	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Industri-Plex - Woburn, MA

Laboratory Reagent Blank

Client Sample ID:	N/A	Lab Sample ID:	N/A
Date of Collection:	N/A	Matrix	Water
Date of Digestion:	7/22/05	Final Volume:	50 mL
Date of Analysis:	7/25/05	Digestate Dilution:	1
Volume Digested:	50 mL	pH:	N/A

CAS Number	Parameter	Concentration ug/L	RL ug/L	Qualifier
7429-90-5	Aluminum	ND	200	
7440-36-0	Antimony	ND	100	
7440-38-2	Arsenic	ND	200	
7440-39-3	Barium	ND	30	
7440-41-7	Beryllium	ND	10	
7440-43-9	Cadmium	ND	30	
7440-70-2	Calcium	ND	200	
7440-47-3	Chromium	ND	30	
7440-48-4	Cobalt	ND	30	
7440-50-8	Copper	ND	30	
7439-89-6	Iron	ND	100	
7439-92-1	Lead	ND	100	
7439-95-4	Magnesium	ND	200	
7439-96-5	Manganese	ND	20	
7440-02-0	Nickel	ND	60	
7440-09-7	Potassium	ND	4000	
7782-49-2	Selenium	ND	100	
7440-22-4	Silver	ND	30	
7440-23-5	Sodium	ND	2000	
7440-28-0	Thallium	ND	200	
7440-62-2	Vanadium	ND	30	
7440-66-6	Zinc	ND	30	

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

METALS MATRIX SPIKE (MS) RESULTS

Industri-Plex - Woburn, MA

Sample ID: AA51324

PARAMETER	SPIKE ADDED mg/Kg	SAMPLE CONCENTRATION mg/Kg	MS CONCENTRATION mg/Kg	MS % REC	QC LIMITS (% REC)
Antimony	161	ND	130	81	75 - 125
Arsenic	161	ND	175	109	75 - 125
Barium	161	40	207	104	75 - 125
Beryllium	64.4	ND	64.3	100	75 - 125
Cadmium	80.5	ND	69.0	86	75 - 125
Chromium	161	17	173	97	75 - 125
Cobalt	161	ND	156	97	75 - 125
Copper	161	22	182	99	75 - 125
Lead	161	250	415	102	75 - 125
Manganese	161	24	178	96	75 - 125
Nickel	161	ND	157	98	75 - 125
Selenium	161	ND	179	111	75 - 125
Silver	32.2	ND	27.3	85	75 - 125
Thallium	161	ND	136	85	75 - 125
Vanadium	161	24	182	98	75 - 125
Zinc	161	45	187	88	75 - 125

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Laboratory Duplicate Results

Industri-Plex - Woburn, MA

Sample ID: AA51331

PARAMETER	SAMPLE RESULT mg/Kg	SAMPLE DUPLICATE RESULT mg/Kg	PRECISION RPD %	QC LIMITS
Aluminum	7400	8400	13	30
Antimony	ND	ND	NC	30
Arsenic	ND	ND	NC	30
Barium	30	35	15	30
Beryllium	ND	ND	NC	30
Cadmium	ND	ND	NC	30
Calcium	2700	3100	14	30
Chromium	18	20	11	30
Cobalt	21	25	17	30
Copper	26	31	18	30
Iron	17000	19000	11	30
Lead	55	62	12	30
Magnesium	3100	3500	12	30
Manganese	790	950	18	30
Nickel	14	16	13	30
Potassium	520	530	2	30
Selenium	ND	ND	NC	30
Silver	ND	ND	NC	30
Sodium	ND	ND	NC	30
Thallium	ND	ND	NC	30
Vanadium	24	27	12	30
Zinc	84	96	13	30

Comments:

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Laboratory Fortified Blank (LFB) Results

Industri-Plex - Woburn, MA

PARAMETER	LFB AMOUNT SPIKED ug/L	LFB RESULT ug/L	LFB RECOVERY %	QC LIMITS %
Aluminum	1000	1000	100	85 - 115
Antimony	1000	960	96	85 - 115
Arsenic	1000	970	97	85 - 115
Barium	1000	1000	100	85 - 115
Beryllium	400	400	100	85 - 115
Cadmium	500	450	90	85 - 115
Calcium	10000	9600	96	85 - 115
Chromium	1000	990	99	85 - 115
Cobalt	1000	980	98	85 - 115
Copper	1000	1000	100	85 - 115
Iron	1000	990	99	85 - 115
Lead	1000	940	94	85 - 115
Magnesium	10000	9700	97	85 - 115
Manganese	1000	980	98	85 - 115
Nickel	1000	980	98	85 - 115
Potassium	10000	10000	100	85 - 115
Selenium	1000	990	99	85 - 115
Silver	200	180	90	85 - 115
Sodium	10000	11000	110	85 - 115
Thallium	1000	1000	100	85 - 115
Vanadium	1000	990	99	85 - 115
Zinc	1000	930	93	85 - 115

Comments:

Samples in Batch: AA51321, AA51322, AA51323, AA51324, AA51325, AA51326, AA51327, AA51328, AA51329, AA51330, AA51331, AA51332, AA51333, AA51334

US ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND LABORATORY

Solid Laboratory Control Sample (LCS) Results

Industri-Plex - Woburn, MA

PARAMETER	LCS RESULTS mg/Kg	CONTROL LIMITS mg/Kg
Aluminum	5380	3950 - 9710
Antimony	57.4	10.0 - 168
Arsenic	141	108 - 164
Barium	148	112 - 169
Beryllium	71.1	54.8 - 78.8
Cadmium	234	201 - 291
Calcium	3310	2680 - 4180
Chromium	96.0	75.0 - 116
Cobalt	46.9	36.2 - 53.1
Copper	71.4	51.2 - 81.4
Iron	10100	6920 - 17200
Lead	75.9	59.8 - 88.6
Magnesium	1880	1560 - 2520
Manganese	252	197 - 307
Nickel	75.3	59.3 - 86.1
Potassium	1920	1400 - 2540
Selenium	86.9	60.7 - 100
Silver	132	77.8 - 176
Sodium	403	221 - 579
Thallium	113	90.7 - 149
Vanadium	103	80.0 - 134
Zinc	131	107 - 166

Comments:

Woburn, MA 7/11/05

10:15 On site at Industri-Plex
w/ M. Lowney & J. Turgeon
for sampling

JT - cal. D.O meter
RF - cal. pH meter at lab

First sample location:

culvert into pond — upstream side of culvert
— low flow occurring — almost stagnant

IP-CULV-01 1030
42° 30' 47.822" N
71° 08' 26.825" W
pH = 6.68 HACH color wheel screen > 3.0 mg/L
D.O - 1.65 mg/L detection limit
Temp 20.1 °C

IP-CONS-01 1110
HALL'S BROOK & RR DRAINAGE combining
42° 30' 45.759" N
71° 08' 30.209" W

pH - 7.12
DO - 6.15
Temp 20.7 °C

PIC 1 – dry swale – w/rip rap bottom into pond
– no flow – no sample
FACING SOUTH

PIC 2 – IP – COMB – 01 FACING W

* HACH AMMONIA COLOR UNIT WE DISCONTINUED BECAUSE OF LOW DETECTION LIMITS

PIC 3 – IP – CULV – 01 FACING W

IP – OUTLET – 01
OUTLET of HALLS BROOK HOLDING AREA POND.

1215 pH – 6.98
DO – 6.62 mg/L
TEMP – 23.3 °C

42° 30' 39.569" N
71° 08' 23.970" W

PIC 4. PIC 5? IP – OUTLET – 01 FACING W

1:15 PM ~20 ft upstream from confluence of RR drainage & Halls Brook in Halls Brook – @ 185 NEW BOTTOM ST UPSTREAM OF CINDER BLOCKS

IP – 185NB – Halls Ø2
– Halls Ø2D
– Halls Ø1 – MS/MSD

TEMP 22.2 °C
DO – 6.46 mg/L
pH – 6.98

42° 30' 47.701" N
71° 08' 53.915" W

PIC 5 – facing upstream (west pair JL)
@ IP – 185NB – Halls Ø1

PIC 6 – facing upstream (north pair JL)
@ IP – 185NB – RRØ1

42°30'47.623"N 71°8'32.977"W
13:26 IP – 185NB – RRØ1 collected
D.O. 5.42 mg/L
temp = 23.8°C
– low, ~~temp~~ flow – but steady
– channel ~50% coverage w/ mud on bottom
– pH 7.17

1P - LANDFILL - RA-02
AT CENTER CULVERT ~~NEXT TO~~
ACROSS ST FROM ANDOVER ATC T-STOP

1115 42° 31' 06.811" N
71° 08' 46.786" W
DO 5.03 mg/L
TEMP 24.8 °C
pH - 6.95

PIC 7 - 1P - LANDFILL - RA-02
DOWNSTREAM FACING S

1P - LANDFILL LF-01
55' W of RA STREAM IN 2nd FACING SET

430 42° 31' 06.806" N GPS @
71° 08' 47.460" W 5' UP BANK
DO 5.32 mg/L
TEMP 26.2 °C
pH 7.00

PIC 8 - 1P - LANDFILL - ~~LF~~ LF-01
55' UPSTREAM OF RA STREAM
FACING W / UPSTREAM

1P - LANDFILL - LF-02
AT UPSTREAM CULVERT 450' W of RA 02

1500 42° 31' 06.558" N
RA 6.99 71° 08' 52.997" W
TEMP 24.2 °C
DO = 3.80 mg/L 15' UP BANK NORTH OF SAMPLE

PIC 9 1P-LANDFILL-LF-02
UPSTREAM W

PIC 10 SAME LOCATION / DIRECTION
CLOSE-UP OF STREAM

1P - RA-03
AT ~~DOWNSTREAM~~ CULVERT ON W SIDE OF COMMUTER RAIL TRACKS

1535
pH = 6.74
TEMP = 26.2 °C
DO = 5.42 mg/L

42° 31' 17.184" N
71° 08' 50.648" W

PIC 11 - 1P-RA-03
FACING S / DOWNSTREAM

1P - RR - 04

AT LR OVERPASS FACING RD NE. SLIP

PIC 12 FACING UPSTREAM / S

:6.62
: 5.53 mg/L 42°31'46.187" N
: 23.9°C 71° 09' 16.672" W

ABOUT 8' ~~UPSTREAM~~ OF BANK -
NO GPS LOCK - POOR SAT. GEOMETRY
TIME = 1605

1P - HAWS - 22MAPLE - 01

~~43°30'~~ 42° 30' 52.037" N
1655 71° 08' 48.792" W
by GPS ON RD BY HYDRANT N 30° W OF BRIDGE

pH 6.52
DO 5.30 mg/L
TEMP 23.2°C

PIC 13 - N SIDE OF BRIDGE FACING SOUTH ACROSS BRIDGE. FLOW FROM L->R

1P - HAWS - 20 THIRD - 01

DOWNSTREAM OF SMALL BRIDGE @ 20 THIRD ST
1715 42°30'48.087" N
71°08'52.765" W

PH: 6.93 GPS NOT DATA LOGGED -
DO 4.80 POOR SAT. GEOMETRY
TEMP 24.2

Woburn, MA 7/12/05

* FOR ALL LAT/LONS, USE LAST 2 PAGES FOLLOWING, NOT NUMBERED UNDER RC-XX, JT

10:30 First sample collected
RC-01 - west side of path in low-lying area
- soil sample for metals analysis
- peaty, roots
~~RC-01 42° 29' 39.779" N 71° 07' 49.417" W~~

10:55 RC-02
RC-02 - west side of path in
71°07'49.516" W low-lying area
42° 29' 39.880" N - north of RC-01
- peaty, roots

11:00 RC-03
- next one north of RC-02
RC-03 42° 29' 40.118" N 71° 07' 49.483" W
- peaty, roots

11:05 RC-04 → 42° 29' 40.874" N
71° 07' 49.502" W next one north of RC-03
- peaty, roots

PIC LOG: RC-01 → RC-12 in ascending order moving north

RC-05 1110
- peaty, roots
42° 29' 41.241" N
71° 07' 50.102" W

RC-06 1115
42° 29' 41.651" N 71° 07' 50.192" W
- peaty, roots

RC-07 1125
- peaty, roots
42° 29' 41.121" N 71° 07' 50.197" W

RC-08 1130
42° 29' 42.696" N 71° 07' ~~50.608"~~ 49.826" W
- peaty, roots

RC-09 1145
42° 29' ~~43.507"~~ 42.224" N 71° 07' 50.668" W 180
- peaty, roots

RC-10 1150
- peaty, roots

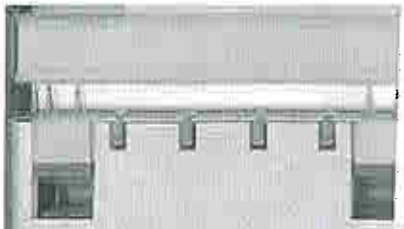
RC-11 1200
- peaty, roots

RC-12 1210
- peaty, roots

GPS FILE "RIFLE CLUB RD" IS A LINE AS RF WALKED THE PATH ALONG THE SAMPLING SITES. PATH IS PARALLEL TO SITES.

Woburn, MA 7/12/05
- also in "RIFLE CLUB ROAD" FILE IS A POINT AT ONE OF THE WELLS (6850)

- THE PATH IS IN TWO FILES:
-1 CALLED PATH AS A POINT FEATURE,
THE OTHER AS A LINE FEATURE, CALLED RC PATH



RC-01 42° 29' 39.479" N
71° 07' 49.417" W

RC-02 42° 29' 39.890" N
71° 07' 49.515" W

RC-03 42° 29' 40.112" N
71° 07' 49.483" W

RC-04 42° 29' 40.879" N
71° 07' 49.782" W

RC-05 42° 29' 41.241" N
71° 07' 50.102" W

RC-06 42° 29' 41.651" N
71° 07' 50.334" W

RC-07 42° 29' 42.121" N
71° 07' 50.193" W

RC - 08 42° 29' 42.646" N
71° 07' 49.826" W

RC - 09 42° 29' 43.224" N
71° 07' 50.180" W

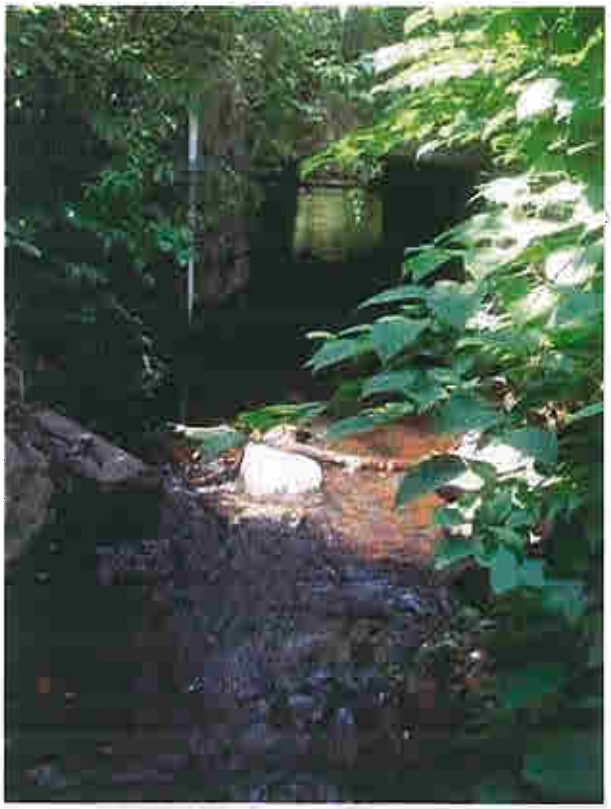
RC - 10 42° 29' 43.358" N
71° 07' 50.608" W

RC - 11 42° 29' 43.827" N
71° 07' 50.634" W

RC - 12 42° 29' 44.234" N
71° 07' 50.749" W

IndustriPlex Water and Soil Sampling Locations, July 11-12, 2005

Dry Swale into Pond, with rip-rap bottom. No flow/no sample taken. Facing South.



IP-COMB-01. Facing West

IP-CULV-01 Facing West

IP-OUTLET-01 Facing West

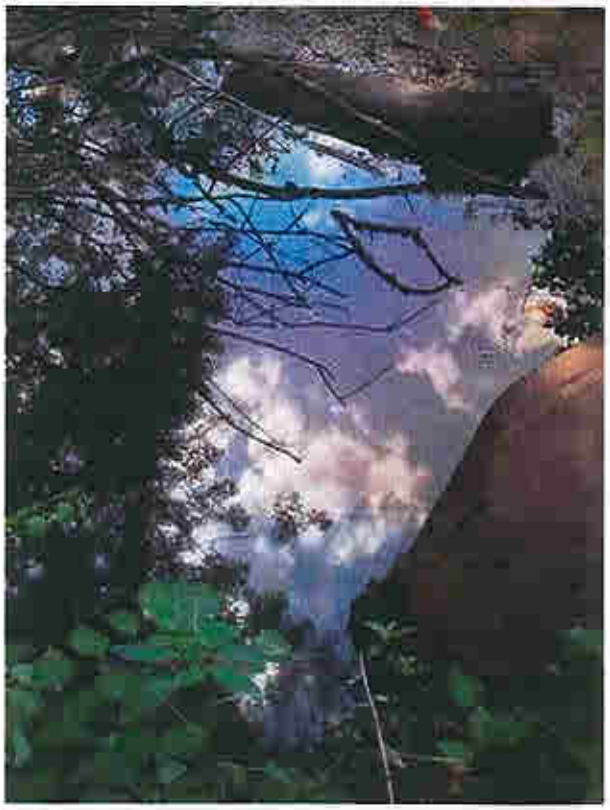
IP-185NB-HALLS01. Facing West (upstream)

IP-185NB-RR01. Facing North (upstream)

IP-LANDFILL-RR-02. Facing South (downstream)

IP-LANDFILL-LF-01. Facing West (upstream)

IP-LANDFILL-LF-02. Facing West (upstream)



IP-LANDFILL-LF-02. Close-up of sheen.

IP-RR-03. Facing South (downstream)

IP-RR-04. Facing South (upstream)

IP-HALLS-22MAPLE-01. North side of brook, facing South across brook. Flow from right to left.

IP-RC-01

IP-RC-02

IP-RC-03

IP-RC-04

IP-RC-05

IP-RC-06

IP-RC-07

IP-RC-08

IP-RC-09

IP-RC-10

Soil and Surface Water Sampling for the Industri-Plex (OU-2)
Superfund Site
Woburn, Massachusetts

Collection of Surface Soil Samples for Metals Analysis and Surface Water Samples for Ammonia and Nitrate Analysis.

Quality Assurance Project Plan (QAPP)

July, 2005

U.S. Environmental Protection Agency
EPA New England
Office of Environmental Measurement & Evaluation
Investigations & Analysis Unit

Project Officer: Joseph F. LeMay, Remedial Project Manager

Project Officer Signature: _____

Office of Quality Assurance Acceptance:

Signature: _____

Date: _____

1. **Project Name:** Soil and Surface Water Sampling for the Industri-Plex and Wells G&H Superfund Sites

2. **Site No:** 0107 - (Industri-Plex OU-2)

3. **Project Requested By:** Joseph F. LeMay (OSRR)

4. **Date of Request:** July 7, 2005 (informal request: 6/29/05)

5. **Date of Project Initiation:** June 30, 2005

6. **Project Officer:** Joseph F. LeMay (OSRR)

7. **Quality Assurance Officer:** See Performance Coordinator

8. **Project Description:** Collection of surface soil samples from various locations for metals analysis and surface water samples from various locations for ammonia and nitrate analysis.

A. Objective and Scope Statement:

Please note the 2005 sampling requested by the site RPM is a continuation of a previously approved EIA sampling projects, (QAPPs dated July 2002 and February 2004).

Updates:
The purpose of the field study is for EPA's Investigations & Analysis Unit (EIA) to gather surface soil and surface water samples from designated locations for analysis in support of an evaluation by the Office of Site Remediation and Restoration (OSRR) of the Industri-Plex Superfund Site, Operable Unit 2 (OU-2). The Request for Sampling and Analysis Assistance is for 15 surface water samples (2/3 depth below surface) along New Boston Street Drainway from southern Wilmington to Halls Brook and along Halls Brook west of Halls Brook Holding Area Pond/ RR tracks and for 15 soil samples (0" - 6") along a foot path on the eastern side of Wells G&H Superfund Site Wetlands (between the former production wells G and H). See attached figures illustrating the proposed sampling locations. The locations may be modified in the field by the Project Officer. Sampling locations will be identified and flagged in the field, located by GPS, and also digitally photographed.

The soil samples will be analyzed for total metals at the EPA New England Regional Laboratory (NERL) in North Chelmsford, MA. The surface water samples will be analyzed for nitrates at NERL and will be analyzed for ammonia by Alpha Analytical.

B. Data Usage

Data from the sample analysis will be used by the EPA for risk screening and/or enforcement purposes.

C. Monitoring Event Design:

The Project Officer will provide EPA-EIA with GIS or areal maps of the major sampling areas, along with the proposed sampling locations in each area labeled on the map. Alternatively, the Project Officer can meet with the Sampling Leader at the site one to two weeks prior to the sampling event and can flag the sampling locations.

The Project Officer has specified that approximately 15 surface soil samples be collected to a depth of 6" at approximately 50 ft intervals along a foot path on the eastern side of Wells G&H Superfund Site Wetlands (between the former production wells G and H). The Project Officer has specified that up to 15 surface water samples be collected from the New Boston Street Drainway from southern Wilmington to Halls Brook and along Halls Brook west of Halls Brook Holding Area Pond/ RR tracks. Ambient field measurements of pH, dissolved oxygen (D.O.) and temperature will be recorded for each surface water sample collected.

D. Monitoring Parameters and Frequency of Collection:

Parameter	Number of Samples	Sample Matrix	Analytical Method Reference	Sample Container	Sample Preservation	Holding Time
Metals	15 QC sample	Soil	EPA 200.7 EIASOP-INGICP6	8 oz. clear wide mouth	Ice	6 mos.
Ammonia	15 QC sample	Aqueous	S.M. 4500	250 ml plastic	H_2SO_4 pH <2 Ice	28 days
Nitrate	15 QC sample	Aqueous	EPA 300.0 EIASOP-INGDXIC8	50 ml plastic or glass	Ice	48 hrs

9. Schedule of Tasks and Products:

Date	Activity
July 7, 2005	Request OEME lab support
July 8, 2005	Sampling team field reconnaissance
July 11 - July 13, 2005	Conduct field sampling
Daily (during sampling period)	Deliver samples to Chelmsford laboratory
July, 2005	Laboratory analyses
August, 2005	Data to Sampling Leader
August, 2005	Data to Project Officer

10. Project Organization and Responsibility:

The following is a list of key project personnel and their responsibilities:

Responsibility	Contact
Project Manager	Joseph LeMay (OSRR)
Sampling Leader	Rich Fisher (EIA)
Sampling QC	Rich Fisher (EIA)
Laboratory Analysis	Peter Philbrook (EIA)
Laboratory QC	Peter Philbrook (EIA)
Performance Auditing	QA Office (EQA)
Overall Performance Coordination	Rich Fisher (EIA)

11. Data Quality Requirements and Assessments

Accuracy and Precision values are for method internal QA/QC. The values are to be considered as goals because some specific compounds are know outside these goals.

Parameter	Sample Matrix	Quant. Limit (mg/KG or mg/L)	Accuracy (%)	Precision (%)	Field Precision
Metals	Soil	As, Cr, and Pb: (See Note below)	75 - 125%	20%	50%
Ammonia	Water	**	75 - 125%	35%	50%
Nitrate	Water	**	75 - 125%	35%	50%

*Samples that are above the calibration range, will be diluted and re-analyzed to within an acceptable calibration range.
** See referenced SOP's for specific analyte reporting limits.
***Accuracy determined with matrix spike (MS) samples and precision determined with either matrix spike duplicate (MSD) samples or laboratory fortified blanks.

12. Data Representativeness:

In general the data obtained from the sample analysis will be used for risk screening and/or enforcement purposes. At least 85% of data must be valid. If data are incomplete, the project manager and OEME personnel will determine if additional sampling is needed.

13. Sampling Procedures:
Samples will be collected in accordance with EPA Investigations & Analyses SOPs.

14. Sample Custody Procedures:

Samples will be handled in accordance with EPA Investigations & Analyses SOP for Chain of Custody. Each sample will be given a unique number and recorded in the field logbook and/or site map.

15. Calibration Procedures and Preventative Maintenance:
Equipment to be directly used during the field sampling event does not require calibration or preventative maintenance. EPA-NE lab procedures and preventive maintenance are documented in the lab QA plan.

16. Documentation, Data Reduction, and Reporting:

All information will be recorded on the Sampling Team's field data sheets.
In addition, the completion of chain of custody (COC) forms, labels, etc. is required for all samples.
Laboratory documentation is maintained in their respective QA plans.

17. Data Validation:

The ammonia ,nitrate, and metals data will be reviewed as specified in the NERL QAP including a review by a peer chemist and by the Chemistry Team Leader.

18. Performance and Systems Audits:
May be performed by the QA Office, as requesting by the Project Officer.

19. Corrective Action:
Any corrective action will be determined by the sampling operations leader and project manager, if necessary, and documented in a field data sheet and/or field logbook.

20. Reports will be sent to: Joseph F. LeMay, RPM
EPA Region 1 - New England
Industri-Plex (OU-2) Superfund Sites

APPENDIX C

SUPPORTING INFORMATION FOR RISK EVALUATION

C.1 – HUMAN HEALTH RISK EVALUATION TABLES

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Water	Surface Water	HBHA Pond	Recreational User	Teenager	Dermal	Qual	Teens may use this area for recreation (wading) with low frequency.
						Inhalation	None	Inhalation exposures are expected to be negligible.
						Ingestion	None	Since surface waters are shallow, wading but not swimming is expected, and ingestion is unlikely.
Future	Soil	Surface Soil	RC Area (Wells G&H Wetland)	Recreational User	Adult/ Young Child	Ingestion	Quant	Recreational users may be exposed to contaminants in soil along the recreation trail.
						Dermal	Quant	Dermal contact with contaminated soils may occur.
						Inhalation	None	Inhalation exposures are expected to be negligible.
	Groundwater	Groundwater	Industri-plex Site/HBHA Pond Area	Car Wash Worker	Adult	Ingestion	None	Direct contact with groundwater is not assumed.
						Dermal	None	Direct contact with groundwater is not assumed.
						Inhalation	Quant	Workers may be exposed to volatile contaminants impacting air during use of groundwater in a hot water car wash.

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Groundwater used in a Car Wash
Exposure Medium: Indoor Air

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Northern Study Area (a)	7664-41-7	Ammonia	N/A	319697	ug/m3	N/A	N/A	N/A	319697	N/A	10 N	N/A	N/A	Y	ASL

(a) Refer to Appendix C.2 for data set utilized.

(1) Groundwater contributions to indoor air have been presented in the Maximum Concentration field. Refer to Appendix C.3 for model results.
(2) Maximum concentration used for screening.
(3) Refer to supporting information for background discussion.
(4) USEPA Region 9 PRGs for ambient air (adjusted to an hazard quotient = 0.1 for noncarcinogens), October 2004.
(5) Rationale Codes:
Selection Reason: Above Screening Levels (ASL)
No Screening Level (NSL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions:
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
PRG = Preliminary Remedial Goal
N/A = Not Applicable or Not Available
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
MCL = Maximum Contaminant Level

TABLE 2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
HBHA Pond	7664-41-7	Ammonia	100	17200	ug/L	HBHA Pond Outlet (9/16/2001)	31 / 31	N/A	17200	N/A	30000	N/A	N/A	N	BSL

(a) Refer to Appendix C.2 for data set.
(1) Minimum/maximum detected concentration.
(2) Maximum concentration used for screening.
(3) Refer to supporting information for background discussion.
(4) Given as a concentration in drinking water, specifically related to taste threshold. Safe concentration may be higher (EPA, 2004).
(5) Rationale Codes: Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

EPA, 2004 - 2004 Drinking Water Standards and Health Advisory

Definitions:
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
PRG = Preliminary Remedial Goal
N/A = Not Applicable or Not Available
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
AWQC = Ambient Water Quality Criterion for Human Health (2002d)

TABLE 2.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
RC soil	7429-90-5	Aluminum	N/A	13000	mg/Kg	RC-10	N/A	N/A	13000	N/A	7600 N	N/A	N/A	Y	ASL
	7440-36-0	Antimony	N/A	12	mg/Kg	RC-11	N/A	N/A	12	N/A	3.1 N	N/A	N/A	Y	ASL
	7440-39-3	Barium	N/A	75.5	mg/Kg	RC-08	N/A	N/A	75.5	N/A	540 N	N/A	N/A	N	BSL
	7440-70-2	Calcium	N/A	9400	mg/Kg	RC-05	N/A	N/A	9400	N/A	N/A	N/A	N/A	N	NUT
	7440-47-3	Chromium	N/A	26	mg/Kg	RC-03	N/A	N/A	26	N/A	22 N	N/A	N/A	Y	ASL
	7440-48-4	Cobalt	N/A	21	mg/Kg	RC-12	N/A	N/A	21	N/A	90 N	N/A	N/A	N	BSL
	7440-50-8	Copper	N/A	79	mg/Kg	RC-03	N/A	N/A	79	N/A	N/A	N/A	N/A	N	NTX
	7439-89-6	Iron	N/A	20000	mg/Kg	RC-03	N/A	N/A	20000	N/A	N/A	N/A	N/A	N	NTX
	7439-92-1	Lead	N/A	370	mg/Kg	RC-05	N/A	N/A	370	N/A	400 N	N/A	N/A	N	BSL
	7439-95-4	Magnesium	N/A	3100	mg/Kg	RC-12	N/A	N/A	3100	N/A	N/A	N/A	N/A	N	NUT
	7439-96-5	Manganese	N/A	1600	mg/Kg	RC-01	N/A	N/A	1600	N/A	180 N	N/A	N/A	Y	ASL
	7440-02-0	Nickel	N/A	14	mg/Kg	RC-12	N/A	N/A	14	N/A	160 N	N/A	N/A	N	BSL
	7440-09-7	Potassium	N/A	535	mg/Kg	RC-08	N/A	N/A	535	N/A	N/A	N/A	N/A	N	NUT
	7440-23-5	Sodium	N/A	640	mg/Kg	RC-04	N/A	N/A	640	N/A	N/A	N/A	N/A	N	NUT
	7440-62-2	Vanadium	N/A	48	mg/Kg	RC-03	N/A	N/A	48	N/A	7.8 N	N/A	N/A	Y	ASL
	7440-66-6	Zinc	N/A	84	mg/Kg	RC-12	N/A	N/A	84	N/A	2300 N	N/A	N/A	N	BSL

(a) Data presented are from soil samples RC-01 through RC-12. See Appendix C.2 for data set.
(1) Minimum/maximum detected concentration.
(2) Maximum concentration used for screening.
(3) Refer to supporting information for background discussion.
(4) USEPA Region 9 PRGs for residential soil (adjusted to an hazard quotient = 0.1 for noncarcinogens), October 2004.
PRG for chromium VI used for chromium.

The screening toxicity value for lead is the residential soil lead guidance level of 400 mg/Kg (USEPA, 1994a).

(5) Rationale Codes:
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions:
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
PRG = Preliminary Remedial Goal
N/A = Not Applicable or Not Available
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Groundwater used in a Car Wash
Exposure Medium: Indoor Air

Exposure Point (1)	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration (2)			
						Value	Units	Statistic (3)	Rationale
Northern Study Area	Ammonia	N/A	N/A	N/A	N/A	3.7E+04	ug/m^3	95% UCL - NP	N/A

(1) Refer to Appendix C.2 for data set.
(2) Refer to Appendix C.3 for air modeling results.
(3) Statistics: Maximum Detected Value (Max); 95% UCL of Transformed Data (95% UCL - T); 95% UCL of Normal Data (95% UCL - N); 95% UCL of Non-parametric Data (95% UCL - NP); Arithmetic Mean (Mean); These statistics apply to the groundwater data set prior to air modeling.

J = Estimated Concentration
Max = Maximum Detected Concentration
N/A = Not Applicable
UCL = Upper Confidence Limit
EPC = Exposure Point Concentration
RME = Reasonable Maximum Exposure
CT = Central Tendency

TABLE 3.2.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point (1)	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (2)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (3)	Rationale (4)
RC Soil									
	Aluminum	mg/kg	N/A	N/A	1.3E+04	1.3E+04	mg/kg	Max	(a)
	Antimony	mg/kg	N/A	N/A	1.2E+01	1.2E+01	mg/kg	Max	(a)
	Chromium	mg/kg	N/A	N/A	2.6E+01	2.6E+01	mg/kg	Max	(a)
	Manganese	mg/kg	N/A	N/A	1.6E+03	1.6E+03	mg/kg	Max	(a)
	Vanadium	mg/kg	N/A	N/A	4.8E+01	4.8E+01	mg/kg	Max	(a)

(1) Refer to Appendix C.2 for data set; only COPCs selected on Table 2.3 appear.
(2) T - Transformed; N - Normal; NP - Non-parametric; G - Gamma; <4 - sample size too small to calculate 95% UCL
(3) Statistics: Maximum Detected Value (Max); 95% UCL of Transformed Data (95% UCL - T); 95% UCL of Normal Data (95% UCL - N); 95% UCL of Non-parametric Data (95% UCL - NP); 95% UCL of Gamma Distributed Data (95% UCL - G); Arithmetic Mean (Mean)
(4) Rationale:

(a) Due to small sample size (<4), the maximum detected concentration is used.
(b) When the maximum detected concentration is selected as the RME EPC, the arithmetic mean concentration is selected as the CT EPC.
(c) If the arithmetic mean concentration equals or exceeds the maximum detected concentration, the maximum detected concentration is used as the CT EPC.
(d) Shapiro-Wilk W Test indicates data are normally distributed.
(e) Shapiro-Wilk W Test indicates data are log-normally distributed.
(f) Shapiro-Wilk W Test indicates data are neither normally nor log-normally distributed.
(g) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC
(h) A-D Test and/or K-S Test indicates data are gamma distributed.

J = Estimated Concentration
Max = Maximum Detected Concentration
N/A = Not Applicable
UCL = Upper Confidence Limit
EPC = Exposure Point Concentration
RME = Reasonable Maximum Exposure
CT = Central Tendency

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation of volatiles	Car Wash Worker	Adult	Northern Study Area	CA	Chemical Concentration in Air	see Table 3s	ug/m^3	see Table 3s	Chronic Daily Intake (CDI) (ug/m^3) = $\frac{CA \times ET \times EF \times ED}{AT \times CF}$
				ET	Exposure Time	8	hrs/day	USEPA, 1997a	
				EF	Exposure Frequency	250	days/year	USEPA, 1997a	
				ED	Exposure Duration	25	years	USEPA, 1997a	
				CF	Conversion Factor	24	hrs/day	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Recreational User	Young Child	RC soil	CS	Chemical Concentration in Soil	see Table 3s	mg/kg	see Table 3s	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR	Ingestion Rate of Soil	200	mg/day	USEPA, 1994b	$\frac{CS \times IR \times FI \times EF \times ED \times CF}{BW \times AT}$
				FI	Fraction Ingested	0.5	unitless	Prof. Judgement	
				EF	Exposure Frequency	78	days/year	assumption	
				ED	Exposure Duration	6	years	USEPA, 1994b	
				BW	Body Weight	15	kg	USEPA, 1994b	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	
				CF	Conversion Factor	0.000001	kg/mg	--	
Dermal	Recreational User	Young Child	RC soil	CS	Chemical Concentration in Soil	see Table 3s	mg/kg	see Table 3s	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,800	cm^2	USEPA, 2004d	$\frac{CS \times SA \times AF \times EF \times ED \times DAF \times CF}{BW \times AT}$
				AF	Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 2004d	
				EF	Exposure Frequency	78	days/year	assumption	
				ED	Exposure Duration	6	years	USEPA, 1994b	
				DAF	Dermal Absorption Factor	chemical specific	--	--	
				BW	Body Weight	15	kg	USEPA, 1994b	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	
				CF	Conversion Factor	0.000001	kg/mg	--	

Young child SA term assumes exposure to face, forearms, hands, lower legs, and feet.

Young child AF term is geometric mean value for children playing in wet soil.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
INDUSTRI-PLEX SUPERFUND SITE

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units	(1)	Value (2)	Units			Source(s)	Date(s) (MM/DD/YYYY)
Aluminum	Chronic	1E+00	mg/kg-day	0.01	1.0E-02	mg/kg-day	CNS	100	STSC	01/05/05
Antimony	Chronic	4E-04	mg/kg-day	0.15	6.0E-05	mg/kg-day	General Toxicity	1000	IRIS	01/05/05
Chromium (VI)	Chronic	3E-03	mg/kg-day	0.025	7.5E-05	mg/kg-day	GI System	300	IRIS	01/05/05
Manganese (other media)	Chronic	7E-02	mg/kg-day	0.04	2.8E-03	mg/kg-day	CNS	3	IRIS	01/05/05
Vanadium	Chronic	1E-03	mg/kg-day	0.026	2.6E-05	mg/kg-day	Kidney	300	STSC	01/05/05

(1) Oral absorption efficiencies from RAGS, Part E (USEPA, 2004a).

(2) Calculated as: (oral RfD) x (oral to dermal adjustment factor).

(3) RfD for managanese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day). The remaining intake (5 mg/day) is divided by 70 kg.

IRIS = Integrated Risk Information System

STSC = Superfund Technical Support Center

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
INDUSTRI-PLEX SUPERFUND SITE

Chemical of Potential Concern (1)	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Ammonia	Chronic	1.00E+02	ug/m^3	N/A	N/A	Respiratory	30	IRIS	8/1/2005

IRIS = Integrated Risk Information System
N/A = Not Applicable

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
INDUSTRI-PLEX SUPERFUND SITE

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	N/A	N/A	N/A	N/A	N/A	D	IRIS	01/05/05
Chromium (VI)	N/A	N/A	N/A	N/A	N/A	D	IRIS	01/05/05
Manganese (other media)	N/A	N/A	N/A	N/A	N/A	D	IRIS	01/05/05
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

IRIS = Integrated Risk Information System
RME = Reasonable Maximum Exposure
CT = Central Tendency
N/A = Not Applicable

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen (by the oral route)
E - Evidence of noncarcinogenicity

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

INDUSTRI-PLEX SUPERFUND SITE

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Ammonia	N/A	N/A	N/A	N/A	D	IRIS	08/01/05

N/A = Not Applicable

IRIS = Integrated Risk Information System

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen (by the oral route)

E - Evidence of noncarcinogenicity

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Car Wash Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Indoor Air	Northern Study Area	Inhalation	Ammonia	4E+04	ug/m3	3.0E+03	ug/m3	N/A	N/A	N/A	8.5E+03	ug/m3	1.0E+02	ug/m3	8.5E+01
			Exp. Route Total								N/A					9E+01
		Exposure Point Total									N/A					9E+01
	Exposure Medium Total										N/A					9E+01
Medium Total											N/A					9E+01
											Total of Receptor Risks Across All Media					N/A
																Total of Receptor Hazards Across All Media 9E+01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Surface Soil	RC soil	Ingestion													
				Aluminum	1E+04	mg/kg	1.6E-03	mg/kg-day	N/A	N/A	N/A	1.9E-02	mg/kg-day	1.0E+00	mg/kg-day	1.9E-02
				Antimony	1E+01	mg/kg	1.5E-06	mg/kg-day	N/A	N/A	N/A	1.7E-05	mg/kg-day	4.0E-04	mg/kg-day	4.3E-02
				Chromium (VI)	3E+01	mg/kg	3.2E-06	mg/kg-day	N/A	N/A	N/A	3.7E-05	mg/kg-day	3.0E-03	mg/kg-day	1.2E-02
				Manganese (other medi	2E+03	mg/kg	2.0E-04	mg/kg-day	N/A	N/A	N/A	2.3E-03	mg/kg-day	7.0E-02	mg/kg-day	3.3E-02
				Vanadium	5E+01	mg/kg	5.9E-06	mg/kg-day	N/A	N/A	N/A	6.8E-05	mg/kg-day	1.0E-03	mg/kg-day	6.8E-02
			Exp. Route Total								N/A					2E-01
			Dermal													
			Exp. Route Total								N/A					N/A
		Exposure Point Total									N/A					2E-01
	Exposure Medium Total										N/A					2E-01
Medium Total											N/A					2E-01
											Total of Receptor Risks Across All Media					N/A
																Total of Receptor Hazards Across All Media	2E-01

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Car Wash Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Indoor Air	Northern Study Area	Ammonia	--	--	--	--	N/A	Respiratory	--	9E+01	--	9E+01
			Chemical Total	--	--	--	--	N/A		--	9E+01	--	9E+01
			Radionuclide Total										
		Exposure Point Total						N/A					9E+01
	Exposure Medium Total							N/A					9E+01
Medium Total								N/A					9E+01
Receptor Total								N/A					9E+01

-- = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: N/A

Total Hazard Across All Media: 9E+01

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	N/A
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	N/A
Total Respiratory HI =	9E+01

C.2 - DATA SETS USED FOR HUMAN HEALTH RISK CALCULATIONS

TABLE 1. GROUNDWATER AMMONIA RESULTS

NSAMPLE	PARAMETER	EPASAMNO	LAB_RESULT	QUAL	UNITS
CB1-04-GW-01NS-110701	Nitrogen, Ammonia	CB1-04-GW-01NS-110701	2150		MG/L
CB2-05-GW-02	Nitrogen, Ammonia	CB2-05-GW-02	13.3		MG/L
CB2-05-GW-03R	Nitrogen, Ammonia	CB2-05-GW-03R	73		MG/L
CB2-06-GW-02NS	Nitrogen, Ammonia	CB2-06-GW-02NS	8.51		MG/L
CB3-02-GW-01NS	Nitrogen, Ammonia	CB3-02-GW-01NS	270	J	MG/L
CB3-02-GW-03	Nitrogen, Ammonia	CB3-02-GW-03	322	J	MG/L
CB3-03-GW-03	Nitrogen, Ammonia	CB3-03-GW-03	49.5	J	MG/L
CB4-03-GW-03	Nitrogen, Ammonia	CB4-03-GW-03	156	J	MG/L
CB4-04-GW-01NS	Nitrogen, Ammonia	CB4-04-GW-01NS	2.7		MG/L
CB4-04-GW-02NS	Nitrogen, Ammonia	CB4-04-GW-02NS	1.87		MG/L
CB4-05-GW-03NS	Nitrogen, Ammonia	CB4-05-GW-03NS	21.9		MG/L
CB5-01-GW-01	Nitrogen, Ammonia	CB5-01-GW-01	16.3	J	MG/L
CB5-02-GW-02	Nitrogen, Ammonia	CB5-02-GW-02	720	J	MG/L
CB5-02-GW-03	Nitrogen, Ammonia	CB5-02-GW-03	281	J	MG/L
CB5-03-GW-03	Nitrogen, Ammonia	CB5-03-GW-03	2710		MG/L
CB6-03-GW-01	Nitrogen, Ammonia	CB6-03-GW-01	276		MG/L
CB6-03-GW-02	Nitrogen, Ammonia	CB6-03-GW-02	1910		MG/L
CB6-03-GW-03	Nitrogen, Ammonia	CB6-03-GW-03	859		MG/L
CB7-01-GW-01	Nitrogen, Ammonia	CB7-01-GW-01	27.4		MG/L
CB7-01-GW-03	Nitrogen, Ammonia	CB7-01-GW-03	0.13	U	MG/L
CB7-02-GW-01	Nitrogen, Ammonia	CB7-02-GW-01	76	J	MG/L
CB7-02-GW-02	Nitrogen, Ammonia	CB7-02-GW-02	11.4	J	MG/L
CB7-03-GW-01	Nitrogen, Ammonia	CB7-03-GW-01	195		MG/L
CB7-03-GW-02R	Nitrogen, Ammonia	CB7-03-GW-02R	348		MG/L
CB7-03-GW-03	Nitrogen, Ammonia	CB7-03-GW-03	1380		MG/L
CB8-01-GW-01-AVG	Nitrogen, Ammonia	CB8-01-GW-01	5.11		MG/L
CB8-01-GW-03	Nitrogen, Ammonia	CB8-01-GW-03	73.3		MG/L
CB8-04-GW-02NS-AVG	Nitrogen, Ammonia	CB8-04-GW-02NS	2235		MG/L
CB9-01-GW-01	Nitrogen, Ammonia	CB9-01-GW-01	583	J	MG/L
CB9-01-GW-03	Nitrogen, Ammonia	CB9-01-GW-03	891	J	MG/L
CB9-02-GW-02	Nitrogen, Ammonia	CB9-02-GW-02	47	J	MG/L
CB9-04-GW-01	Nitrogen, Ammonia	CB9-04-GW-01	3.52		MG/L
CB9-05-GW-01	Nitrogen, Ammonia	CB9-05-GW-01	2.17		MG/L
CE3-02-GW-03	Nitrogen, Ammonia	CE3-02-GW-03	0.04	U	MG/L
CE4-02-GW-01	Nitrogen, Ammonia	CE4-02-GW-01	12.2		MG/L
CE4-03-GW-01NS-072301	Nitrogen, Ammonia	CE4-03-GW-01NS-072301	104		MG/L
CE4-03-GW-03-AVG	Nitrogen, Ammonia	CE4-03-GW-03	0.42		MG/L
CH1-04-GW-04	Nitrogen, Ammonia	CH1-04-GW-04	0.055	UJ	MG/L
CH1-04-GW-05R	Nitrogen, Ammonia	CH1-04-GW-05R	0.092	UJ	MG/L
CH2-02-GW-02	Nitrogen, Ammonia	CH2-02-GW-02	2.5	J	MG/L
CH2-02-GW-05	Nitrogen, Ammonia	CH2-02-GW-05	2.54	J	MG/L
CH2-04-GW-05	Nitrogen, Ammonia	CH2-04-GW-05	0.63	J	MG/L
CH2-04-GW-06	Nitrogen, Ammonia	CH2-04-GW-06	0.24	UJ	MG/L
CL2-03-GW-01	Nitrogen, Ammonia	CL2-03-GW-01	0.18	UJ	MG/L
CL2-03-GW-02-AVG	Nitrogen, Ammonia	CL2-03-GW-02	0.059	UJ	MG/L
CL2-05-GW-01NS	Nitrogen, Ammonia	CL2-05-GW-01NS	11.3	J	MG/L
CL2-05-GW-03	Nitrogen, Ammonia	CL2-05-GW-03	0.11	UJ	MG/L
CW5-03-GW-01	Nitrogen, Ammonia	CW5-03-GW-01	4	J	MG/L
CW5-03-GW-02R-AVG	Nitrogen, Ammonia	CW5-03-GW-02R	66.4		MG/L

TABLE 1. GROUNDWATER AMMONIA RESULTS

NSAMPLE	PARAMETER	EPASAMNO	LAB_RESULT	QUAL	UNITS
CW5-03-GW-03NS	Nitrogen, Ammonia	CW5-03-GW-03NS	249		MG/L
CW5-05-GW-02R	Nitrogen, Ammonia	CW5-05-GW-02R	2370	J	MG/L
CW5-05-GW-03	Nitrogen, Ammonia	CW5-05-GW-03	616	J	MG/L
CW5-08-GW-01	Nitrogen, Ammonia	CW5-08-GW-01	1.4		MG/L
P1-01-GW-01-041201	Nitrogen, Ammonia	P1-01-GW-01-041201	1.97		MG/L
P1-01-GW-01R	Nitrogen, Ammonia	P1-01-GW-01R	1.42		MG/L
P1-01-GW-02	Nitrogen, Ammonia	P1-01-GW-02	0.11	U	MG/L
P1-01-GW-02R	Nitrogen, Ammonia	P1-01-GW-02R	0.04	U	MG/L
P1-01-GW-03R	Nitrogen, Ammonia	P1-01-GW-03R	0.04	U	MG/L
P1-01-GW-04R	Nitrogen, Ammonia	P1-01-GW-04R	0.049	J	MG/L
P1-01-GW-05R-AVG	Nitrogen, Ammonia	P1-01-GW-05R	0.051		MG/L
P1-01-GW-06NS-110701	Nitrogen, Ammonia	P1-01-GW-06NS-110701	0.3		MG/L
P1-01-GW-07NS	Nitrogen, Ammonia	P1-01-GW-07NS	0.16		MG/L
P1-01-GW-08NS-111301	Nitrogen, Ammonia	P1-01-GW-08NS-111301	0.27		MG/L
P1-02-GW-01	Nitrogen, Ammonia	P1-02-GW-01	8.7		MG/L
P1-02-GW-02	Nitrogen, Ammonia	P1-02-GW-02	19.5		MG/L
P1-02-GW-03	Nitrogen, Ammonia	P1-02-GW-03	8.02		MG/L
P1-02-GW-04-AVG	Nitrogen, Ammonia	P1-02-GW-04	0.28		MG/L
P1-02-GW-05NS-110501	Nitrogen, Ammonia	P1-02-GW-05NS-110501	1.13		MG/L
P1-02-GW-06NS-110601	Nitrogen, Ammonia	P1-02-GW-06NS-110601	1.15		MG/L
P1-02-GW-07NS	Nitrogen, Ammonia	P1-02-GW-07NS	0.24		MG/L
P1-03-GW-01	Nitrogen, Ammonia	P1-03-GW-01	0.087	UJ	MG/L
P1-03-GW-02	Nitrogen, Ammonia	P1-03-GW-02	0.079	UJ	MG/L
P1-03-GW-03	Nitrogen, Ammonia	P1-03-GW-03	0.3	U	MG/L
P1-03-GW-04	Nitrogen, Ammonia	P1-03-GW-04	0.11	U	MG/L
P1-03-GW-05NS	Nitrogen, Ammonia	P1-03-GW-05NS	0.74		MG/L
P1-03-GW-06NS-051601	Nitrogen, Ammonia	P1-03-GW-06NS-051601	0.38		MG/L
P1-04-GW-01	Nitrogen, Ammonia	P1-04-GW-01	0.34		MG/L
P1-04-GW-02-AVG	Nitrogen, Ammonia	P1-04-GW-02	1.82		MG/L
P1-04-GW-03	Nitrogen, Ammonia	P1-04-GW-03	0.072	UJ	MG/L
P1-04-GW-04	Nitrogen, Ammonia	P1-04-GW-04	0.065	UJ	MG/L
P1-05-GW-01	Nitrogen, Ammonia	P1-05-GW-01	0.22	U	MG/L
P1-05-GW-02	Nitrogen, Ammonia	P1-05-GW-02	1.46		MG/L
P1-05-GW-03	Nitrogen, Ammonia	P1-05-GW-03	1.86		MG/L
P1-05-GW-04NS	Nitrogen, Ammonia	P1-05-GW-04NS	0.16	U	MG/L
P1-05-GW-05	Nitrogen, Ammonia	P1-05-GW-05	0.071	UJ	MG/L
P1-06-GW-01	Nitrogen, Ammonia	P1-06-GW-01	0.042	UJ	MG/L
P1-06-GW-02	Nitrogen, Ammonia	P1-06-GW-02	0.072	UJ	MG/L
P1-06-GW-03	Nitrogen, Ammonia	P1-06-GW-03	0.39		MG/L
P1-06-GW-04	Nitrogen, Ammonia	P1-06-GW-04	0.088	UJ	MG/L
P1-07-GW-01-AVG	Nitrogen, Ammonia	P1-07-GW-01	0.052	UJ	MG/L
P1-07-GW-02	Nitrogen, Ammonia	P1-07-GW-02	0.085	UJ	MG/L
P1-07-GW-03NS-073101	Nitrogen, Ammonia	P1-07-GW-03NS-073101	0.078	J	MG/L

TABLE 2. SURFACE WATER AMMONIA RESULTS

Location	Date	Depth (cm)	Depth (ft)	NH3-N mg N/L
WN50	11/30/1999	50	1.6	9.5
WC50	11/30/1999	50	1.6	9.36
WS50	11/30/1999	50	1.6	9.58
WN50	4/4/2000	50	1.6	7.4
WC50	4/4/2000	50	1.6	7.6
WS50	4/4/2000	50	1.6	7.9
WN50	8/25/2000	50	1.6	13.1
WC50	8/25/2000	50	1.6	14.8
WS50	8/29/2000	50	1.6	16
WN50	4/2/2001	50	1.6	5.4
WC50	4/2/2001	50	1.6	5
WS50	4/2/2001	50	1.6	5.3
WC50	9/17/2001	50	1.6	16.4
WS50	9/17/2001	50	1.6	15.1
WS50	9/20/2004	50	1.6	2
Hall's Brook Inlet	4/5/2000	10	0.33	5.2
	5/18/2000	10	0.33	7.8
	8/30/2000	10	0.33	7.6
	4/5/2001	10	0.33	5.5
	9/16/2001	10	0.33	4.1
	9/20/2004	10	0.33	3.3
Atlantic Ave. Drainway	4/5/2000	10	0.33	0.1
	4/5/2001	10	0.33	2.2
	9/20/2004	10	0.33	0.7
HBHA Pond Outlet	4/5/2000	10	0.33	7.4
	5/18/2000	10	0.33	8
	8/30/2000	10	0.33	16
	4/5/2001	10	0.33	6.9
	9/16/2001	10	0.33	17.2
	9/20/2004	10	0.33	4
IP-OUTLET-01	7/11/2005	NA	NA	3.81

Notes

NA = not applicable or not available

TABLE 3. SURFACE SOIL SAMPLING RESULTS - RC SAMPLES
INDUSTRI-PLEX OU-2 (INCLUDING WELLS G OU-3) SUPERFUND SITE

Sample ID:	RC-01	RC-02	RC-03	RC-04	RC-05	RC-06	RC-07
Sample Date:	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05
Matrix:	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment
Lab Sample ID:	AA51321	AA51322	AA51323	AA51324	AA51325	AA51326	AA51327
Contaminant (mg/kg)							
Aluminum	4,600	9,100	9,000	3,800	8,300	3,100	2,900
Antimony	9.8 U	15 U	16 U	16 U	12 U	10 U	11 U
Arsenic	20 U	30 U	32 U	32 U	24 U	20 U	22 U
Barium	56	48	48	40	37	21	13
Beryllium	0.98 U	1.5 U	1.6 U	1.6 U	1.2 U	1.0 U	1.1 U
Cadmium	2.9 U	4.5 U	4.8 U	4.8 U	3.6 U	3.1 U	3.3 U
Calcium	2,300	8,000	3,700	4,800	9,400	720	98
Chromium	13	21	26	17	22	17	3.7
Cobalt	11	4.7	5.0	4.8 U	3.9	3.1 U	3.3 U
Copper	20	29	79	22	21	16	4.0
Iron	5,700	13,000	20,000	7,800	7,700	4,300	2,900
Lead	69	140	240	250	370	280	52
Magnesium	830	900	690	370	620	150	69
Manganese	1,600	94	33	24	23	9.3	3.8
Nickel	9.5	11	11	9.6 U	7.3	6.2	6.6 U
Potassium	390 U	600 U	640 U	640 U	490	410 U	440 U
Selenium	9.8 U	15 U	16 U	16 U	12 U	10 U	11 U
Silver	2.9 U	4.5 U	4.8 U	4.8 U	3.6 U	3.1 U	3.3 U
Sodium	200 U	300 U	320 U	640	240 U	200 U	220 U
Thallium	20 U	30 U	32 U	32 U	24 U	20 U	22 U
Vanadium	14	36	48	24	37	28	9.5
Zinc	53	79	57	45	41	23	5.8

TABLE 3. SURFACE SOIL SAMPLING RESULTS - RC SAMPLES
INDUSTRI-PLEX OU-2 (INCLUDING WELLS G OU-3) SUPERFUND SITE

Sample ID:	RC-08	RC-08D	RC-09	RC-09D	RC-10	RC-11	RC-12
Sample Date:	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05	12-Jul-05
Matrix:	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment	Soil/Sediment
Lab Sample ID:	AA51328	AA51332	AA51334	AA51333	AA51329	AA51330	AA51331
Contaminant (mg/kg)							
Aluminum	5,400	4,900	3,100	3,900	13,000	2,200	7,400
Antimony	13 U	9.8 U	10 U	10 U	11 U	12	9.7 U
Arsenic	26 U	20 U	20 U	20 U	23 U	20 U	19 U
Barium	73	78	40	51	17	7.0	30
Beryllium	1.3 U	0.98 U	1.0 U	1.0 U	1.1 U	0.99 U	0.97 U
Cadmium	3.9 U	2.9 U	3.0 U	3.0 U	3.4 U	3.0 U	2.9 U
Calcium	6,000	5,400	5,400	7,100	440	130	2,700
Chromium	12	9.4	12	16	16	8.4	18
Cobalt	7.6	7.5	3.0 U	3.7	4.6	3.0 U	21
Copper	21	20	19	24	17	11	26
Iron	6,400	6,600	6,700	8,400	7,300	3,600	17,000
Lead	200	170	240	280	190	160	55
Magnesium	1,000	600	360	480	690	85	3,100
Manganese	37	38	33	50	24	6.4	790
Nickel	11	11	6.6	7.8	7.2	5.9 U	14
Potassium	530	540	400 U	400 U	460 U	400 U	520
Selenium	13 U	9.8 U	10 U	10 U	11 U	9.9 U	9.7 U
Silver	3.9 U	2.9 U	3.0 U	3.0 U	3.4 U	3.0 U	2.9 U
Sodium	260 U	200 U	200 U	200 U	230 U	200 U	190 U
Thallium	26 U	20 U	20 U	20 U	40 U	20 U	40 U
Vanadium	18	16	21	26	40	28	24
Zinc	64	67	56	73	33	17	84

C.3 – AIR MODELING

APPENDIX C.3
AIR MODELING

1.0 INTRODUCTION

This appendix contains a description of the methods and assumptions used to evaluate inhalation exposures to ammonia following its release to air during groundwater use in a warm water car wash.

The purposes of this evaluation are: 1) to evaluate the potential human health risks that may be posed by ammonia contamination of groundwater at the Industri-plex site area; and 2) to provide a basis for decisions as to whether remedial action is necessary for ammonia in groundwater.

This assessment provides estimates of risk under a hypothetical future groundwater use scenario (use of groundwater in a warm water car wash) for the reasonable maximum exposed (RME) receptor, used to represent the maximum (upper-bound) exposure that is reasonably expected to occur.

2.0 HAZARD IDENTIFICATION

To evaluate the impact of future industrial and commercial groundwater use on indoor air quality, the maximum detected groundwater ammonia concentration presented in Table 1 of this appendix (2,710,000 ug/L) was modeled to an indoor air concentration using methods and assumptions provided in Table 2 of this appendix. Indoor air concentrations were modeled based on the use of groundwater in a warm water car wash. For estimation of air concentration in a warm water car wash, the shower model approach presented by Foster and Chrostowski (1986; 1987) was assumed to be proportionally representative of conditions similar to a car wash. The modeling equations and model inputs are provided on Table 2. A Henry's Law Constant (ATSDR, 2002) applicable to ammonia at pH 7 was selected for use in the modeling based on site-specific groundwater pH measurements which indicate that groundwater pH ranges from 4.64 to 8.04 at the site, with most measured values below pH 7. The model adjusts the Henry's Law Constant for its application to a temperature of 45 °C (113 °F). The maximum

modeled indoor air concentration is presented in Table 2.1 of Appendix C.1 (319,697 ug/m^3). Because only one air concentration was modeled (based on the maximum groundwater concentration), only one air concentration (i.e., the maximum predicted concentration) appears on Table 2.1 of Appendix C.1.

The maximum modeled indoor air concentration of ammonia was compared to its ambient air preliminary remedial goal (PRG) published by USEPA Region 9 (USEPA, 2004b) to determine whether further evaluation of ammonia was warranted. PRGs are chemical concentrations back-calculated using toxicity criteria and either a 1 x 10^{-6} target risk level for potential carcinogens or a hazard quotient (HQ) of 1 for noncarcinogens. For purposes of this screening analysis, a HQ of 0.1 was used to add a ten-fold measure of safety to reduce the chance of omitting ammonia from the list of chemicals that could contribute to a total hazard index (HI) of 1. To accomplish this, the ammonia PRG was divided by 10 prior to comparison to its maximum modeled value resulting in an adjusted PRG of 10 ug/m^3. Because the maximum modeled air concentration exceeded the Region 9 ambient air PRG (Table 2.1 in Appendix C.1), further risk evaluation of ammonia was performed.

3.0 EXPOSURE AND TOXICITY ASSESSMENT

Because USEPA recommends the use of the UCL providing 95% coverage on the arithmetic mean concentration for the estimation of RME risk (USEPA 1989; 1992; 1994; 2002; and 2004a), ammonia groundwater data were used to generate a groundwater UCL value which was then modeled to estimate an airborne UCL ammonia concentration a worker may be exposed to during warm water car wash use. The groundwater ammonia UCL was calculated using USEPA's program "ProUCL Statistical Software" (version 3.0). Table 4 in this appendix provides the ProUCL output for the groundwater data. Table 3.RME in this appendix summarizes the mean, maximum, and 95% UCL groundwater values. The 95% UCL groundwater concentration (316,000 ug/L) was then modeled to a 95% UCL airborne ammonia concentration (37,300 ug/m^3). Table 5 in this appendix documents the groundwater UCL, assumptions used in the modeling, and the inputs to the model. The same model and assumptions used to generate the maximum ammonia indoor air concentration were used to predict a 95% UCL indoor air ammonia concentration. Tables 3.1.RME in Appendix C.1 lists the modeled UCL ammonia air

concentrations used to evaluate the car wash water use scenario.

Car wash workers are assumed to be exposed to volatile COPCs in indoor air only. For the inhalation pathway, the exposure time was assumed to be equivalent to a typical 8-hour work day for both the CT and RME cases (USEPA, 1997). An exposure frequency of 250 days/year was used, representative of the 95th percentile number of days worked per year. The default high-end exposure duration of 25 years was used for the RME case (USEPA, 1997). An ammonia inhalation reference concentration (RfC; 100 ug/m^3) from the Integrated Risk Information System (IRIS; USEPA, 2005) was used, in conjunction with the exposure assumptions, to estimate noncarcinogenic hazard for the car wash scenario. Based on available information, ammonia is not a classified as a known, probable, or potential carcinogen. Therefore, only noncarcinogenic ammonia hazards have been further evaluated.

4.0 RISK CHARACTERIZATION AND CLEANUP LEVEL DEVELOPMENT

Risk characterization combines estimates of exposure with toxicity data to develop estimates of the probability that an adverse effect will occur under the specified conditions of exposure. Noncancer hazard is estimated by means of a Hazard Quotient (HQ). To calculate the noncarcinogenic HQ, the following equation was used:

$$HQ = (CA \times ET \times EF \times ED) / (CF \times AT \times RfC)$$

Where:

CA = modeled 95% UCL ammonia concentration in air (37,300 ug/m^3)

ET = exposure time (8 hours/day)

EF = exposure frequency (250 days/year)

ED = exposure duration (25 years)

CF = conversion factor (24 hours/day)

AT = averaging time (9,125 days)

RfC = reference concentration (100 ug/m^3)

The HQ for ammonia (85) exceeds the target HQ of 1. Therefore, ammonia was determined as posing a future potential risk to human health. Based on this determination, a cleanup goal was

developed for ammonia based on the same methods and assumptions used to estimate the noncancer hazard for ammonia. Using the following proportionality, a groundwater cleanup goal was estimated:

$$\frac{\text{95\% UCL groundwater concentration}}{\text{RME HQ}} = \frac{\text{groundwater PRG}}{\text{target HQ}}$$

Where:

95% UCL Groundwater Concentration = 316,000 ug/L
RME HQ = 85
Target HQ = 1
Groundwater PRG = 3,718 ug/L (rounded to 4,000 ug/L or 4 mg/L)

5.0 REFERENCES

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TABLE 1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER TO AIR
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Include? (Y/N)
Northern Study Area (a)	7664-41-7	Ammonia	49 J	2710000	ug/L	CB5-03-GW-03	67 / 92	20 - 150	Y

(a) Refer to Appendix C.2 for data set.

(1) Minimum/maximum detected concentration.

TABLE 2. SHOWER MODEL
FOSTER AND CHROSTOWSKI
Future Adult Scenario - Northern Study Area Groundwater in Car Wash - Maximum Detected Concentrations[1]

	Estimation of Gas-Phase Mass Transfer Coefficient (cm/hr) $k_{g(VOC)}$			Estimation of Liquid-Phase Mass Transfer Coefficient (cm/hour) $k_{l(VOC)}$			Estimation of Overall Mass Transfer Coefficient (cm/hr) K_L			Temperature Adjusted Overall Mass Transfer Coefficient (cm/hr) -- K'L K'_L					Maximum Concentration Leaving the Shower Droplet C_{wd}				VOC Generation Rate in the Shower Room S			VOC Air Concentration in the Shower Room (for t <= D_s) $C_a(t)$			
	$k_{g(VOC)} = k_{g(H2O)} (18 / MW)^{0.5}$			$k_{l(VOC)} = k_{l(CO2)} (44 / MW)^{0.5}$			$K_L = (1/k_{l(VOC)} + RT / H k_{g(VOC)})^{-1}$			$K'_L = K_L (T_1 u_s / T_s u_1)^{0.5}$					$C_{wd} = C_{ww} (1 - \exp [-K_{al} t_s / 60 d])$				$S = C_{wd} (FR) / SV$			$C_a(t) = (S/R) (1 - \exp[-R t])$			
Analyte	$k_{g(H2O)}$ cm/hr	MW g/mole	$k_{g(VOC)}$ cm/hr	$k_{l(CO2)}$ cm/hr	MW g/mole	$k_{l(VOC)}$ cm/hr	H atm-m^3/mole	RT atm-m^3/mole	K_L cm/hr	T_1 K	Ts K	u_1 cp	u_s cp	K'_L cm/hr	C_{ww} ug/L	t_s sec	d mm	C_{wd} ug/L	FR l/min	SV m^3	S ug/m^3-min	R min^{-1}	D_s min	t min	$C_a(t)$ mg/m^3
Ammonia	3.00E+03	1.70E+01	3.08E+03	2.00E+01	1.70E+01	3.21E+01	7E-06	2.40E-02	8.14E-01	2.93E+02	3.18E+02	1.00E+00	5.96E-01	1.10E+00	2.71E+06	2E+00	1E+00	4.94E+04	1E+01	6E+00	7.24E+04	8.33E-03	1.50E+01	5E+00	3.20E+02

Notes:

[1] See Table 1 for analytes retained for analysis.

MW = Molecular weight (g/mole)
$k_{g(H2O)}$ = Gas phase mass transfer coefficient for H_2O (cm/hr)
$k_{g(VOC)}$ = Gas-phase mass-transfer coefficient for the analyte (cm/hr)
$k_{l(CO2)}$ = Liquid phase mass transfer coefficient for CO_2 (cm/hr)
$k_{l(VOC)}$ = Liquid-phase mass-transfer coefficient for the analyte (cm/hr)
H = Henry's Law Constant (atm-m^3/mole)
RT = Gas constant-temp factor (atm-m^3/mole)
K_L = Overall Mass-Transfer Coefficient (cm/hr)
T_1 = Calibration water temperature of K_L (K)
Ts = Shower water temperature (range 300-320 K)
u_1 = Water viscosity at T_1 (at 20 C), centipoise (cp)
u_s = Water viscosity at T_s (at 45 C), centipoise (cp)
K'_L = Temp adjusted mass-transfer coefficient (cm/hr)
C_{ww} = Shower water concentration (tap water conc. - ug/L)
t_s = Shower droplet drop time (sec)
d = Shower droplet diameter (millimeters, mm)
C_{wd} = Concentration leaving shower droplet after time t_s (ug/L)
FR = Shower water flow rate (liters/minute, l/m)
SV = Shower room air volume (m^3)
S = VOC generation rate in the shower room (ug/m^3-min)
R = Air exchange rate (min-1)
D_s = Shower duration (min)
t = time (min)
$C_a(t)$ = Time dependent indoor concentration

TABLE 3.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
INDUSTRI-PLEX SUPERFUND SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Point (1)	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (2)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (3)	Rationale (4)
Northern Study Area	Ammonia	ug/L	2.1E+05	3.2E+05 (NP)	2.7E+06	3.2E+05	ug/L	95% UCL - NP	(f)

(1) Refer to Appendix C.2 for data set.
(2) T - Transformed; N - Normal; NP - Non-parametric; G - Gamma; <4 - sample size too small to calculate 95% UCL
(3) Statistics: Maximum Detected Value (Max); 95% UCL of Transformed Data (95% UCL - T); 95% UCL of Normal Data (95% UCL - N); 95% UCL of Non-parametric Data (95% UCL - NP); 95% UCL of Gamma Distributed Data (95% UCL - G); Arithmetic Mean (Mean)
(4) Rationale:

(a) Due to small sample size (<4), the maximum detected concentration is used.
(b) When the maximum detected concentration is selected as the RME EPC, the arithmetic mean concentration is selected as the CT EPC.
(c) If the arithmetic mean concentration equals or exceeds the maximum detected concentration, the maximum detected concentration is used as the CT EPC.
(d) Shapiro-Wilk W Test or Lilliefors Test indicates data are normally distributed.
(e) Shapiro-Wilk W Test or Lilliefors Test indicates data are log-normally distributed.
(f) Shapiro-Wilk W Test or Lilliefors Test indicates data are neither normally nor log-normally distributed.
(g) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC
(h) A-D Test and/or K-S Test indicates data are gamma distributed.

J = Estimated Concentration
Max = Maximum Detected Concentration
N/A = Not Applicable
UCL = Upper Confidence Limit
EPC = Exposure Point Concentration
RME = Reasonable Maximum Exposure
CT = Central Tendency

TABLE 4. PRO UCL OUTPUT

Data File	J:\NE\WELLSG&H\RI Addendum\Groundwater ammonian data for addendum.xls	
Variable:	Ammonia	
Raw Statistics		
Number of Observations	92	
Number of Missing Data	0	
Number of Valid Observations	92	
Number of Distinct Observations	87	
Minimum	0.02	
Maximum	2710	
Mean	208.815	
Standard Deviation	549.7804	
Variance	302258.4	
Coefficient of Variation	2.632859	
Skewness	3.255482	
Too Few Distinct Observations?	NO	
Normal Statistics		
Lilliefors Test Statisitic	0.378055	
Lilliefors 5% Critical Value	0.092372	
Shapiro-Wilk Test Statisitic	N/A	
Shapiro-Wilk 5% Critical Value	N/A	
5% Normality Test Result	NOT NORMAL	Data not normal at 5% significance level
95% Student's-t UCL	304.0653	
Gamma Statistics		
k hat	0.174243	
k star (bias corrected)	0.175807	
Theta hat	1198.415	
Theta star	1187.75	
nu hat	32.06066	
nu star	32.34853	
5% Approximate Chi Square Value	20.34652	
Adjusted Level of Significance	0.047391	
Adjusted Chi Square Value	20.19497	
Anderson-Darling Test Statistic	5.505533	
Anderson-Darling 5% Critical Value	0.93758	
Anderson-Darling 5% Gamma Test Result	NOT AD GAMMA	Data not gamma distributed at 5% significance level
Kolmogrov-Smirnov Test Statistic	0.191751	
Kolmogrov-Smirnov 5% Critical Value	0.104296	
Kolmogrov-Smirnov 5% Gamma Test Result	NOT KS GAMMA	Data not gamma distributed at 5% significance level
5% Gamma Test Result	NOT GAMMA	Data not gamma distributed at 5% significance level
95% Approximate Gamma UCL	331.9909	
95% Adjusted Gamma UCL	334.4822	
Lognormal Statistics		
Minimum of log data	-3.91202	
Maximum of log data	7.904704	
Mean of log data	1.027449	
Standard Deviation of log data	3.659444	
Variance of log data	13.39153	
Lilliefors Test Statisitic	0.099884	
Lilliefors 5% Critical Value	0.092372	
Shapiro-Wilk Test Statisitic	N/A	
Shapiro-Wilk 5% Critical Value	N/A	
5% Lognormality Test Result	NOT LOGNORMAL	Data not lognormal at 5% significance level
MLE Mean	2260.216	
MLE Standard Deviation	1828454	
MLE Coefficient of Variation	808.9731	
MLE Skewness	5.29E+08	
MLE Median	2.79393	
MLE 80% Quantile	61.53953	
MLE 90% Quantile	307.9186	
MLE 95% Quantile	1149.676	
MLE 99% Quantile	13895.45	
MVU Estimate of Median	2.597663	
MVU Estimate of Mean	1406.783	
MVU Estimate of Standard Deviation	155474.1	
MVU Estimate of SE of Mean	1012.006	
95% H-UCL	18670.12	
95% Chebyshev (MVUE) UCL	5818.014	
97.5% Chebyshev (MVUE) UCL	7726.757	
99% Chebyshev (MVUE) UCL	11476.11	
Non-parametric Statisitics		
95% CLT UCL	303.0956	
95% Adjusted-CLT UCL	323.8829	
95% Modified-t UCL	307.3077	
95% Jackknife UCL	304.0653	
95% Chebyshev (Mean, Sd) UCL	458.6608	
97.5% Chebyshev (Mean, Sd) UCL	566.7693	
99% Chebyshev (Mean, Sd) UCL	779.1275	
Bootstrap Statistics		
Number of Bootstrap Runs	2000	
95% Standard Bootstrap UCL	305.1174	
95% Bootstrap-t UCL	337.4971	
95% Hall's Bootstrap UCL	316.1744	
95% Percentile Bootstrap UCL	302.3632	
95% BCA Bootstrap UCL	322.9993	
Recommendations		
Human Inspection Recommended?	YES	
Appropriate Distribution	NON-PARAMETRIC	
1st Recommended UCL	316.1744	95% Hall's Bootstrap UCL
2nd Recommended UCL		
3rd Recommended UCL		
Recommended UCL > Max Data Value		
Recommendation Warning!	PLEASE CHECK	Hall's Bootstrap/Bootstrap-t may yield erratic values,
Alternative UCL	NONE	in that case use 99% Chebyshev (Mean, Sd) UCL

TABLE 5. SHOWER MODEL
FOSTER AND CHROSTOWSKI
Future Adult Scenario - Northern Study Area Groundwater in Car Wash - 95% UCL Concentrations

	Estimation of Gas-Phase Mass Transfer Coefficient (cm/hr) $k_{g(VOC)}$			Estimation of Liquid-Phase Mass Transfer Coefficient (cm/hour) $k_{l(VOC)}$			Estimation of Overall Mass Transfer Coefficient (cm/hr) K_L			Temperature Adjusted Overall Mass Transfer Coefficient (cm/hr) -- K'_L					Maximum Concentration Leaving the Shower Droplet C_{wd}				VOC Generation Rate in the Shower Room S			VOC Air Concentration in the Shower Room (for t <= D_s) $C_a(t)$			
	$k_{g(VOC)} = k_{g(H2O)} (18 / MW)^{0.5}$			$k_{l(VOC)} = k_{l(CO2)} (44 / MW)^{0.5}$			$K_L = (1/k_{l(VOC)} + RT / H k_{g(VOC)})^{-1}$			$K'_L = K_L (T_l u_s / T_s u_l)^{0.5}$					$C_{wd} = C_{ws} (1 - exp [-K_{al} t_s / 60 d])$				$S = C_{wd} (FR) / SV$			$C_a(t) = (S/R) (1 - exp[-R t])$			
Analyte	$k_{g(H2O)}$ cm/hr	MW g/mole	$k_{g(VOC)}$ cm/hr	$k_{l(CO2)}$ cm/hr	MW g/mole	$k_{l(VOC)}$ cm/hr	H atm-m^3/mole	RT atm-m^3/mole	K_L cm/hr	T_l K	Ts K	u_l cp	u_s cp	K'_L cm/hr	C_{ws} ug/L	t_s sec	d mm	C_{wd} ug/L	FR l/min	SV m^3	S ug/m^3-min	R min^{-1}	D_s min	t min	$C_a(t)$ mg/m^3
Ammonia	3.00E+03	1.70E+01	3.08E+03	2.00E+01	1.70E+01	3.21E+01	7E-06	2.40E-02	8.14E-01	2.93E+02	3.18E+02	1.00E+00	5.96E-01	1.10E+00	3.16E+05	2E+00	1E+00	5.77E+03	1E+01	6E+00	8.45E+03	8.33E-03	1.50E+01	5E+00	3.73E+01

Notes:

MW = Molecular weight (g/mole)
$k_{g(H2O)}$ = Gas phase mass transfer coefficient for H_2O (cm/hr)
$k_{g(VOC)}$ = Gas-phase mass-transfer coefficient for the analyte (cm/hr)
$k_{l(CO2)}$ = Liquid phase mass transfer coefficient for CO_2 (cm/hr)
$k_{l(VOC)}$ = Liquid-phase mass-transfer coefficient for the analyte (cm/hr)
H = Henry's Law Constant (atm-m^3/mole)
RT = Gas constant-temp factor (atm-m^3/mole)
K_L = Overall Mass-Transfer Coefficient (cm/hr)
T_l = Calibration water temperature of K_L (K)
Ts = Shower water temperature (range 300-320 K)
u_l = Water viscosity at T_l (at 20 C), centipoise (cp)
u_s = Water viscosity at T_s (at 45 C), centipoise (cp)

K'_L = Temp adjusted mass-transfer coefficient (cm/hr)
C_{ws} = Shower water concentration (tap water conc. - ug/L)
t_s = Shower droplet drop time (sec)
d = Shower droplet diameter (millimeters, mm)
C_{wd} = Concentration leaving shower droplet after time t_s (ug/L)
FR = Shower water flow rate (liters/minute, l/m)
SV = Shower room air volume (m^3)
S = VOC generation rate in the shower room (ug/m^3-min)
R = Air exchange rate (min^{-1})
D_s = Shower duration (min)
t = time (min)
$C_a(t)$ = Time dependent indoor concentration

APPENDIX D

NATIONAL RECOMMENDED WATER QUALTIY CRITERIA TABLES FOR AMMONIA

United States Environmental Protection Agency
Office of Water 4304
EPA-822-R-99-014 December 1999

EPA

1999 Update of Ambient Water Quality Criteria for Ammonia

Supersedes 1998 Update

pH-Dependent Values of the CMC (Acute Criterion)

CMC, mg N/L		
pH	Salmonids Present	Salmonids Absent
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

Temperature and pH-Dependent Values of the CCC (Chronic Criterion) for Fish Early Life Stages Present

CCC for Fish Early Life Stages Present, mg N/L										
pH	Temperature, C									
	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

Temperature and pH-Dependent Values of the CCC (Chronic Criterion) for Fish Early Life Stages Absent

CCC for Fish Early Life Stages Absent, mg N/L										
pH	Temperature									
	0-7	8	9	10	11	12	13	14	15*	16*
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442

* At 15 C and above, the criterion for fish ELS absent is the same as the criterion for fish ELS present.

APPENDIX E

AMMONIA TOXICITY PROFILE

TOXICITY PROFILE

AMMONIA

Ammonia (NH_3) is found throughout the environment in the air, soil, and water. It is also found in plants and animals, including humans. Bacteria found in the intestines can produce ammonia. It occurs naturally and is produced by human activity. As an important nutrient, it does not last long in the environment, but is taken up quickly by plants, bacteria, and animals. It does not biomagnify in the food chain (ATSDR, 2004). Ammonia is manufactured by reacting hydrogen with nitrogen in a reaction called the Haber Process. About 80% of ammonia produced is used in fertilizers. Ammonia is used as a refrigerant gas, in the manufacture of plastics, explosives, pesticides, and other chemicals, as a corrosion inhibitor, in the purification of water supplies, as a cleaning component, in the pulp and paper, metallurgy, rubber, food and beverage, textile, and leather industries, and in the manufacture of pharmaceuticals (ATSDR, 2002). Ammonia is also produced naturally when organic matter decomposes (ATSDR, 2004).

At room temperature, ammonia is a colorless, highly irritating gas with a distinct pungent, suffocating odor. It is lighter than air and can be flammable at high concentrations and temperatures (ATSDR, 2002). This odor is familiar to many people because of its use in smelling salts, many household and industrial cleaners, and window cleaning products. Ammonia is also applied directly to soil as a fertilizer for farm crops, lawns, and plants. It is easily compressed, and forms a clear colorless liquid under pressure (ATSDR, 2002). Ammonia can dissolve easily into water to form the ammonium ion (NH_4^+) and ammonium hydroxide (NH_4OH), an alkaline solution. Ammonia-based cleaning products vary between 5% (household cleaner) and 25% (commercial cleaner) solutions. Commercial strength cleaners are corrosive and commonly stored in steel drums. Once exposed to open air, dissolved ammonia quickly vaporizes (ATSDR, 2004). Adequate ventilation and protective clothing are recommended when using ammonia-based cleaners or fertilizers (ATSDR, 2002).

No adverse health effects have been noted in humans exposed to typical environmental concentrations of ammonia. However, exposure to higher concentrations of airborne ammonia (> 100 ppm) may be irritating to the skin, eyes, throat, and lungs, causing coughing and burns. The irritation may be accompanied by lacrimation, rhinorrhea, and upper airway swelling. These effects are caused by the reaction of moisture in the mucous membranes with ammonia to produce ammonium hydroxide. Lung damage, characterized by bronchiolar and alveolar edema and airway destruction, and death have resulted after exposure to extremely high concentrations of ammonia (> 300 ppm). However, ammonia=s odor threshold (5 ppm) is sufficiently low to provide adequate warning of its presence. Asphyxiation may occur in poorly ventilated or enclosed spaces. Chronic exposure may cause chronic cough, asthma, and lung fibrosis (ATSDR, 2002).

Ingestion of concentrated ammonia solutions can cause corrosive damage to the mouth, throat, and stomach, accompanied by nausea, vomiting, abdominal pain, and esophageal burns. Ingestion of ammonia does not normally result in systemic poisoning due to its rapid (i.e., within minutes) biotransformation in the body to less toxic materials. Ammonia breakdown products typically leave the body within a couple of days (ATSDR 2004). Dilute aqueous solutions (5%) can produce moderate skin irritation. More concentrated solutions can cause pain, inflammation, blisters, necrosis, and deep burns, especially on moist skin. Frostbite injury can occur upon contact with compressed liquid ammonia (ATSDR, 2002).

Airborne concentrations of greater than 50 ppm may produce rapid eye irritation (ATSDR, 2002).

Higher concentrations may cause severe eye injury. Splashing 25% ammonia solutions into the eyes can also cause skin burns and permanent eye damage that may result in blindness (ATSDR, 2004). Cataracts and glaucoma have been reported in people acutely exposed to ammonia vapor.

A level of 300 ppm is considered immediately dangerous to life or health (ATSDR, 2002). There is no antidote for ammonia poisoning, but ammonia=s effects can be treated and most people recover.

Ammonia is an essential metabolite for DNA, RNA, and protein synthesis and is necessary for maintaining acid-base balance. Ammonia is produced and used in all mammalian species, including humans. *Minimal Risk Levels* (MRLs) of 1.7 ppm and 0.1 ppm for acute-duration and chronic-duration inhalation exposures, respectively, have been established. If a person is exposed to ammonia in air at a concentration below the MRL, it is not expected that harmful health effects will occur. No oral MRLs have been derived for ammonia in water. However, the amount of ammonia that can be safely ingested and assimilated may be substantial (tens of mg/kg) based on the various efficient ways by which the body can dispose of ammonia (ATSDR, 2004).

Ammonia has not been classified as to its ability to produce carcinogenicity (ATSDR, 2002). It is also unknown whether ammonia exposure causes birth defects or if ammonia can pass through the placenta to a fetus or pass to infants via breast milk. However, decreased egg production and conception rates have been observed in animals, and ammonia has been shown to cross the ovine placental barrier (ATSDR, 2002).

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. *Managing Hazardous Materials Incidents.* Volume III - Medical Management Guidelines for Acute Chemical Exposures: Ammonia. U.S. Department of Health and Human Services, Public Health Service.

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